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CARDIAC ARREST IN THE OPERATING ROOM

Report of Five Cases Occurring in a Community Hospital

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NO situation in surgery is as urgent as cardiac arrest. The surgeon meets with no other operating-room complication in which indecision and delay are so disastrous. However, dramatic rescue of a dying patient may be achieved by prompt, specific therapy. In a recent review Dale[1] cites a mortality of 69 per cent for 312 collected cases. Stevenson[2] has stated that the mortality in 1000 cases collected from all over the world was 72 per cent. By contrast, Lahey[3] reports a mortality of 30 per cent in the last 10 cases at the Lahey Clinic. Papper[4] states that during the past two years at the Presbyterian Hospital in New York City, the mortality has been 25 per cent. Our own mortality rate is 60 per cent. It is worthy of mention that in a rare case of apparent cardiac arrest in the operating room, spontaneous recovery has occurred without the intervention of any specific therapy.

In a six-month period from October, 1951, to March, 1952, cardiac arrest occurred in 4 cases in the operating room at the Salem Hospital. Our first case had been observed three years earlier. Three of these 5 patients recovered although 1 died fifteen days later. Hence, only 2 of our 5 patients made a complete recovery and were discharged from the hospital. In each case diagnosis had been established by direct inspection of the heart through a thoracotomy incision. Post-mortem examination was performed in 2 of the 3 fatal cases. In 4 cases a regular heart beat was restored by direct cardiac massage.

Current interest in this complication is reflected by the increasing number of articles published within the last two or three years. Cardiac arrest has been the subject of panel discussions at the last two annual meetings of the American College of Surgeons. It is only natural that most of the reports on this subject have come from the larger metropolitan hospitals, but our purpose in this paper is to call attention to the fact that sudden cessation of the heart beat in the operating room also occurs in small community hospitals. This disaster may be encountered by any surgeon, during any type of operation, in young as well as elderly patients and with any of the commonly used anesthetic agents, including spinal and local anesthesia.[5] Therefore, all surgeons and all anesthetists in every hospital must be prepared in advance to recognize the occurrence of cardiac arrest and to deal with it promptly and effectively. The reward for such preparation was realized in our last 2 cases, in which the patients were discharged to their homes without any evidence of cerebral or cardiac damage, after resuscitation from cardiac arrest in the operating room. This salvage was accomplished in 1 case by the surgical resident, and in the most recent case by the youngest member of the surgical staff. For the past six months, a sterile cardiac resuscitation kit has been kept in a prominent position in the operating-room corridor. This kit contains an endotracheal tube, a few dissecting instruments, a costotome, two 10-cc. syringes and four long, 22-gauge needles. In addition, epinephrine (1:1000), sterile saline solution and procaine amide (Pronestyl) are included in the same package. Recently, we have also included a simple electric device for defibrillation of the heart, in the event that ventricular fibrillation is encountered. Dr. Frank Glenn[6] has stated, "The most important instrument is a knife."

CASE REPORTS

CASE 1. P. K., a 54-year-old man, underwent a laparotomy in December, 1948, under ether anesthesia. Colectomy for obstructing carcinoma of the descending colon had been planned. Cardiac arrest occurred 20 minutes after the skin incision had been made. The tumor of the colon had been identified by palpation, but there had been no dissection, blood loss or traction on the bowel. The blood pressure had just been recorded at 130/90, when the anesthetist noted a sudden change in the patient's color. It was quickly determined that no pulse could be felt in the adjacent aorta. Cardiac massage was at first carried out from below the diaphragm, but after several minutes direct cardiac massage was instituted through a thoracotomy incision in the 5th interspace. The pericardium was immediately opened. The heart was firm, contracted and motionless. Cardiac massage was carried out for about 30 minutes to no avail. Epinephrine, 1:1000, diluted with 5 cc. of saline solution, was injected directly into the left ventricle without any response. At post-mortem examination minimal arteriosclerotic changes consistent with the patient's age were demonstrated in the heart and great vessels. Permission for examination of the brain had not been obtained.

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This was our first case of true cardiac arrest. Opportunity for immediate diagnosis was provided since the blood pressure had just been recorded prior to the change in the patient's color. There had been no recognized tracheal obstruction, cyanosis, fall in blood pressure or acute blood loss, which might have explained the cause of cardiac arrest on the basis of hypoxia. Delay in carrying out direct cardiac massage through a new incision in the thorax was unfortunate, but, in 1948, massage of the arrested heart from below an intact diaphragm was still being recommended in the surgical literature. Several surgeons at this hospital, on the basis of their experience with apparent cardiac arrest in other cases not reported in this article, have concluded that arrested hearts were started up once again by massage from below an intact diaphragm. However, the available time for the restoration of the circulation to the brain is so short that the risk of failure of subdiaphragmatic massage cannot be assumed.

CASE 2. P. H., an 86-year-old man, underwent a laparotomy under endotracheal nitrous oxide, oxygen and ether anesthesia on October 1, 1951, because of an obstructing carcinoma of the descending colon. Two weeks earlier, an emergency cecostomy had been done under local anesthesia because of acute large-bowel obstruction. This elderly patient made an excellent recovery from the initial, emergency procedure.

Cardiac arrest occurred 20 minutes after the skin incision had been made at the 2d operation. There had been a transient period of cyanosis during the introduction of anesthesia. Shortly after gentle manual exploration of the abdomen, the nurse anesthetist reported the sudden cessation of respiration. No pulse could be detected on palpation of the abdominal aorta. Cardiac massage was quickly instituted through a thoracotomy incision in the 5th left interspace. The heart was found to be motionless and dilated. Spontaneous respirations were resumed after the heart had been squeezed twice. A spontaneous systole occurred after the 5th massage. Irregular systole finally merged into spontaneous regular rhythm while massage was being continued; 100 mg. of procaine amide (Pronestyl) had been injected into an arm vein as soon as the circulation had been restored by cardiac massage. The chest and abdominal incisions were quickly closed without further effort to resect the carcinoma.

The patient recovered consciousness in 2 hours. During the next 2 days he appeared to have made a complete recovery. No change whatever could be detected in his mental state. An electrocardiogram taken after operation suggested some degree of heart strain, with occasional ectopic beats. Congestive heart failure became apparent about 10 days after operation, and death occurred 5 days later. At post-mortem examination 4 separate carcinomas were found. There was a small primary bronchogenic carcinoma, not demonstrable in x-ray films taken before operation, together with considerable tracheitis and bronchitis. There was also a renal-cell carcinoma of the right kidney and a small carcinomatous polyp of the colon in addition to the obstructing carcinoma of the sigmoid.

We regard this as a case of recovery from acute cardiac arrest in the operating room, despite the fact that the patient died fifteen days later. There was no evidence of cerebral damage from anoxia during the postoperative period. At post-mortem examination, the heart weighed 560 gm. and showed diffuse myocardial fibrosis and coronary atherosclerosis. There had been a brief period of cyanosis about the time when the endotracheal tube was being inserted, but the cardiac arrest occurred long after this incident. Restoration of regular cardiac rhythm followed a minimal period of manual cardiac massage.

CASE 3. M. N., a 71-year-old woman, underwent a left inguinal herniorrhaphy under spinal anesthesia on October 15, 1951. She had appeared to be in good condition. A small amount of supplemental thiopental (Pentothal) had been employed. The operation was completed without incident. A dressing was being placed in the operative wound when cardiac arrest occurred. Slight delay in making the correct diagnosis resulted from some confusion whether or not a peripheral pulse could be detected. Thoracotomy and cardiac massage were suggested and quickly carried out. The heart was found to be somewhat large and in standstill. Spontaneous heart beats were resumed after about 12 squeezes of the heart by the surgeon's hand. Procaine amide (Pronestyl), 200 mg., was injected into an arm vein by the anesthetist simultaneously with the resumption of circulation after cardiac massage. The heart rhythm became perfectly regular in several minutes. The auricles had begun to beat before systole was first apparent in the ventricles. Spontaneous breathing did not begin until 20 minutes had elapsed.

The patient died about 50 hours after operation, and without recovering consciousness. Color, pulse and blood pressure had been restored to satisfactory levels during the immediate postoperative period. Periodic Cheyne-Stokes respiration and generalized clonic convulsive movements occurred about 6 hours after cardiac arrest and were regarded as indicating cerebral damage consequent to anoxia.

Thiopental (Sodium Pentothal) anesthesia had been suspected as an etiologic agent in cardiac arrest, perhaps in association with a period of unrecognized hypoxia. This is the only 1 of our 5 cases in which any thiopental had been employed. Prior to operation and shortly after the induction of spinal anesthesia, a fall in blood pressure from a preoperative systolic level of 170 to a level of 80 had been noted, but the blood pressure promptly returned to a level of 140 after 1 cc. of Neo-synephrine had been injected intravenously. The harmful effect of a relatively brief period of anoxia on the brain cells was well demonstrated in this case. Again, we were surprised at the ease with which the ventricles resumed a regular rhythm after a brief period of manual massage. The hypotension, of short duration, occurred about fifty minutes before the cardiac arrest. Hence, it seems improbable that there was any relation between this brief period of hypotension and the subsequent occurrence of cardiac arrest.

CASE 4. A. C., a 42-year-old housewife, had been referred to the hospital in February, 1952, by one of us (P.R.H.) with a diagnosis of extensive gastric carcinoma. She had had essential hypertension for several years with 2 episodes of mild congestive heart failure. At the time of admission to the hospital she was taking digitalis. Physical examination at admission did not demonstrate the presence of heart disease. Electrocardiograms and x-ray films of the chest were described as being within normal limits. On February 6 endotracheal nitrous oxide, oxygen and ether anesthesia was administered in preparation for laparotomy. Seven minutes after the endotracheal tube had been readily inserted, respirations suddenly ceased, and the pulse and blood pressure became unobtainable. The surgical resident was quickly notified in the adjacent scrub room. (Fortunately, the cardiac arrest kit had become routine equipment in the operating room by this date.) Thoracotomy was quickly carried out through the 5th interspace. Cardiac massage was instituted approximately 3½ minutes after the cessation of respiration had first been noticed. Spontaneous heart beat was resumed after 1 minute of cardiac massage. Color, pulse and blood

pressure promptly returned to satisfactory levels. Initially, 150 mg. of procaine amide (Pronestyl) had been administered intravenously. Medical consultation and electrocardiograms were obtained. Ventricular tachycardia ensued. An additional 850 mg. of procaine amide was administered in divided doses as suggested by the medical consultant during the next few hours while the patient was kept in the operating room. Subsequently, regular cardiac rhythm was restored. The patient made a complete recovery from this episode, although signs of confusion and memory loss were noted during the 1st postoperative week.

Four weeks later laparotomy demonstrated extensive inoperable gastric carcinoma. The value of continuous electrocardiograms in the occasional patient was demonstrated during this 2d procedure when cardiac arrest again occurred after incision of the peritoneum and was instantly recognized. Spontaneous heart beats were resumed 30 seconds later, without the intervention of cardiac massage or the injection of cardiac stimulants. (Of course, such an experience illustrates the well known fact that occasionally a patient recovers from cardiac arrest without the intervention of either cardiac massage or stimulant, *but delay in thoractomy or cardiac massage is not justified by such an uncommon example of spontaneous recovery.*) Subsequently, the patient was discharged to her home, where she died 2 months later from the gastric carcinoma. However, cerebral and cardiac function appeared to have been unaltered by this hospital experience.

This was the youngest patient in this hospital in whom cardiac arrest occurred and the only one of the 5 patients in whom pre-existing hypertension, and known heart disease were present. The anesthetist states that the insertion of the endotracheal tube was readily accomplished a few minutes prior to the occurrence of cardiac arrest. There was no apparent period of even brief hypoxia. Attention is again called to the significant number of reported cases of inhibition of cardiac rhythm, including cardiac arrest, coincident with endotracheal intubation or endotracheal suction or both. Beecher[7] has reported a striking example of such a sequence. Many anesthetists are fearful of the depressing effects of novocain in any form on the cardiac conduction system. Procaine or procaine amide would not at present be given after spontaneous heart beat had been resumed unless a specific indication existed, such as ventricular irritability or tachycardia as demonstrated by electrocardiograms in this case.

Case 5. T. C., a 47-year-old woman, was operated upon on March 25, 1952. Initial dilatation and curettage under spinal anesthesia disclosed what appeared to be a uterine leiomyoma. The surgeon had returned to the adjacent scrub room prior to pelvic laparotomy, when the anesthetist noted the sudden absence of blood pressure and the cessation of breathing. Thoracotomy was immediately performed. The heart was found to beating very feebly at a rate of about 20 a minute. Cardiac massage was instituted, and 0.2 of 1 cc. of 1:1000 epinephrine was injected into the left ventricle simultaneously. The heart rate increased to 60, and the blood pressure became detectable at 130/70. Subsequently, the blood pressure continued to rise to a level of 200. Spontaneous respiration did not begin for 35 minutes. Initially, oxygen was administered with a tight-fitting face mask, but subsequently an endotracheal tube was inserted. The patient remained in the operating room for 5 hours. On removal of the face mask, weakness of the right facial nerve was apparent. Generalized convulsive seizures, occurring every 10 or 15 minutes, began later on in the afternoon after the patient had returned to her room. A neurologic consultant found paralysis of the right facial nerve, a positive right Babinski reflex and deep coma. He made a diagnosis of decerebrate rigidity resulting from cerebral anoxia and expressed the opinion that the prognosis was extremely poor.

Generalized convulsions continued on the following day. Progressive emphysema of the neck, face, arms and upper part of the chest was noted, although the anesthetist had said that the endotracheal tube was inserted quite readily without trauma. A neurologist expressed the opinion that prognosis was hopeless. A cardiologist found that the heart appeared to be normal. The patient first responded on the 3d postoperative day, when the positive Babinski reflex disappeared. On the following day the consulting neurologist considered the degree of recovery "incredible."

The patient improved steadily and was discharged to her home on the 18th postoperative day. There was a memory lapse for 4 days after operation. Subsequently, the patient appeared to have made a complete recovery from her cardiac arrest and brief cardiac anoxia. Six weeks later she was free of symptoms, and neurologic examination was negative. An electroencephalogram is to be obtained.

This is our most gratifying case of apparent complete recovery from cardiac arrest, despite the convulsive seizures occurring in the first few days after the operation. At thoracotomy, the heart was not in a state of arrest but was beating slowly, feebly and ineffectually. Certainly, the circulation of blood had been arrested, and we regard this as a case of cardiac arrest. This case was submitted to the panel on Cardiac Arrest at the recent Clinical Congress of the American College of Surgeons, which expressed the unanimous opinion that such an occurrence should be classified as cardiac arrest.

Incidence

Two comments regarding the incidence of cardiac arrest are justified. In the first place the complication is being recognized more often by the general surgeon who is not operating within the chest. Many surgeons with years of experience can recall cases of sudden unexplained death in the operating room, a number of which were undoubtedly caused by cardiac arrest. Secondly, it is to be expected that cardiac arrest will occur more often at the present time since the heart and other mediastinal structures are operated upon with much greater frequency. In some centers where many operations on the heart are carried out, the occurrence of cardiac arrest in the operating room is anticipated about once a month. At the Lahey Clinic, experience has been reported with 19 cases, and Lahey has stated that they anticipate about 2 cases a year. The coincidence of our 4 recent cases within a six-month period in a 250-bed hospital is startling.

Etiology

It is apparent that not all the causes of cardiac arrest are understood. Such factors as hypoxia, hypercapnia and vagal stimulation are most frequently mentioned. Several circumstances are probably responsible for the more frequent occurrence and the earlier recognition of the complication. The organs in the chest, including the heart, are being operated upon with much greater frequency. Surgery is now undertaken in many elderly or poor-risk patients, in whom hypoxia and an ir-

ritable myocardium would naturally be more prevalent. However, pre-existing heart disease is frequently not present. Arrest has often occurred in young persons.

The role of hypoxia has received the greatest emphasis. Many factors may be productive of hypoxia, in addition to such an obvious circumstance as an obstructed airway. Pre-existing anemia, cardiovascular disease or acute blood loss that is not quickly replaced during the course of operation will result in diminished oxygen supply to the cerebral and cardiac tissues. Excessive preoperative sedation, unrecognized metabolic diseases in which acidosis exists or overdosage of anesthetic agents may also cause hypoxia or hypercapnia. Recent investigators have pointed out that a relative degree of oxygen lack not ordinarily detectable by clinical observation may be found with the aid of special apparatus, such as the oximeter, and may be harmful in certain cases. Thiopental (Sodium Pentothal) has been suspected by several surgeons, who point out that a dangerous degree of hypoxia may exist without detection when thiopental is employed as the principal anesthetic agent.

The role of reflex stimulation of the vagus nerve is disputed. Many authorities express the opinion that arrest of the heart by vagal stimulation must be most unusual in well oxygenated patients. There is recent experimental evidence to support this contention. On the other hand, a number of authors are convinced that stimulation of the vagus nerve plays a large role in the occurrence of cardiac arrest. It has been demonstrated experimentally that the effect of vagal inhibition on cardiac rhythm is greatly enhanced by either hypoxia or hypercapnia. In the absence of these factors, vagal stimulation is not productive of cardiac arrest in laboratory animals.[8] Recently a number of authors have cited cases of cardiac arrhythmia, or arrest, coincident with endotracheal intubation, or even with the withdrawal of the endotracheal tube.[9, 10] In some of the cases reported it is not possible to recognize the existence of hypoxia, and in such cases the role of vagal inhibition is certainly suggested. In the human subject, it is probably wise to acknowledge the possible role of vagal stimulation at a time when the trachea is stimulated in this manner, or dissection of the structures about the hilus of the lungs is being carried out. Beecher[7] has cautioned against prolonged endotracheal toilet or routine bronchoscopy at the end of an intrathoracic operation. In his experience patients have occasionally died unexpectedly under such circumstances.

Some anesthetic agents are known to increase myocardial irritability and exaggerate the response of the myocardium to circulating epinephrine; cyclopropane and chloroform are examples of such agents. Therefore, greater caution must be exercised in the administration of epinephrine by the anesthetist if cyclopropane is the anesthetic agent.

In a number of the reported cases, especially in young patients, it is apparent that no cause has been satisfactorily demonstrated for the occurrence of cardiac arrest. In our own group of 5 cases, cyclopropane was not employed. One patient received a small amount of thiopental (Sodium Pentothal). An endotracheal tube had been inserted in 2 of the 5 cases before operation and long before the occurrence of cardiac arrest. Hypoxia often attends the introduction of an endotracheal tube, but such a causative role was not recognized in these 2 cases. We do not actually know the cause of cardiac arrest in any of these 5 patients, although a number of possible factors, such as age, hypertension and known myocardial disease, were recognized in varying degrees in several cases.

Diagnosis

The responsibility for the early detection of cardiac arrest belongs primarily to the anesthetist for obvious reasons, except in patients in whom the surgeon is operating within the chest or upon major vessels. Johnson and Kirby[11] state that the surgeon must assume that the heart has stopped whenever the anesthetist reports that he is unable to detect a pulse or obtain a blood pressure. Cessation of respiration may prompt the search for a detectable pulse or blood pressure. It is evident that the anesthetist must exercise continuous surveillance, if arrest of the heart action is to be discovered early enough to permit total recovery of the patient. Time is so precious that the anesthetist must report his observations immediately. Death, or at least permanent damage to the brain, will result unless the circulation is restored within three or four minutes. Periodically, cases are described in the newspaper in which life was prolonged and circulation was finally restored, but the victim apparently survived as a decerebrate tragedy. Diagnostic procedures, such as ophthalmoscopy, electrocardiography and even auscultation of the heart, are of academic interest only at this point. The time limit does not permit their use. It has been said that the surgeon should have his hand on the arrested heart within fifteen seconds of notification that cardiac arrest has occurred.[12, 13]

Occasional errors in diagnosis will inevitably occur if the surgeon adopts this prompt, aggressive attitude. Such an error happened in the Salem Hospital in 1947. Thoracotomy and cardiac massage were performed in this case for what was demonstrated at autopsy to have been a massive pulmonary embolus occurring during the performance of a burn dressing under anesthesia. Nevertheless, spontaneous heart beat was resumed for fifteen hours after cardiac massage. Coronary occlusion occurring during the course of an operation may also resemble cardiac arrest, and the heart has been fruitlessly massaged in cases in which coronary thrombosis has been the cause of cessation of the heart beat.

Such errors in diagnosis must be accepted by the surgeon if more patients with cardiac arrest in the operating room are to be saved by prompt treatment.

Cardiac arrest may also occur in patients in the outpatient department, fracture room, cystoscopy room or x-ray department. Salvage of such patients is rare, and it is more difficult to outline routine procedures under these circumstances, when facilities are minimal. However, even in such situations prompt diagnosis followed by thoracotomy and massage of the heart may save a life.

Prophylaxis

Certain measures seem to be of value in lessening the incidence of cardiac arrest. Preoperative administration of atropine not only reduces bronchial secretion, ensuring a more patent airway, but also tends to block cardioinhibitory vagal reflexes. However, it has been stated by some investigators as a result of laboratory experiments that, to block vagal impulses completely, a prohibitively heavy dose of atropine is necessary. Thoracic surgeons are familiar with the value of quinidine before operation in reducing myocardial irritability. Some authorities express the belief that quinidine is more predictable and less hazardous than the more recently introduced procaine amide (Pronestyl), which has been suggested for prophylactic use to lessen the incidence of cardiac arrhythmias during thoracic surgery.[13, 14] Vasoconstrictor drugs should be used with caution, or not at all, if cyclopropane is the anesthetic agent, since cyclopropane increases the irritability of the myocardium, making it more susceptible to the influence of such drugs. The maintenance of a clear airway throughout the operation is important in the prevention of hypoxia. Often, such an adequate airway cannot be obtained without the employment of an endotracheal tube. However, it is worthy of repetition that a number of cases of arrest occurring simultaneously with the introduction of such an endotracheal tube have been reported. This sequel is more likely to occur if the patient is in a stage of light anesthesia when an attempt is made to introduce the tube.[9] It should also be mentioned that the cumulative effects of hypoxia after a prolonged operation may be productive of cardiac arrest and sudden death coincident with endotracheal extubation and suction, as reported by Shumacker and Hampton.[10] Such experience may constitute a valid argument against routine bronchoscopy at the end of operation, as pointed out by Beecher.[7] Maintenance of normal circulating blood volume by transfusion is imperative, because in this manner a diminished venous return to the right side of the heart and resulting hypoxia are combated. Thus, surgical shock with significant alteration of effective circulation to the myocardium should be vigorously corrected.

The role of preoperative apprehension is difficult to appraise. Many surgeons of experience have been reluctant to proceed with a proposed operation on emotionally labile persons who have stated that if the operation is performed they are sure they will die. Efforts must be made to allay preoperative apprehension by adequate sedation of such patients. It has been reasoned that apprehension accelerates the liberation of an excessive amount of epinephrine, with possibly disastrous consequence to the heart. In a recent article Harvey and Levine[15] describe paroxysmal ventricular tachycardia due to emotion. They visualize the possibility of sudden death as a result of ventricular fibrillation. The mechanism of death in the rare patient with an unusual degree of preoperative apprehension may be similar.

Treatment

The treatment of a patient with cardiac arrest has two main objectives: restoration of the oxygen system (the term of Beck and Rand[16]); and restoration of the normal heart beat. Confusion is greatly lessened if treatment is organized in terms of these two goals.

Restoration of the Oxygen System

This urgent need is met first by the introduction of oxygen into the lungs by the anesthetist, and secondly by manual pumping of oxygenated blood from the heart to the brain by the surgeon. The brain cells will not survive anoxia for longer than three or four minutes. The anesthetist provides artificial respiration, employing 100 per cent oxygen, inserting an endotracheal tube without delay if one is not already in place. If such a tube is not immediately available, a tight-fitting face mask must suffice. In this circumstance, the hazard of overdistention of the stomach must be considered. At times, a simple catheter can be readily inserted into the trachea if a laryngoscope and intratracheal tube are not available.

Cardiac massage by the surgeon's hand is so far the single most important therapeutic step, taking precedence over all other resuscitative measures. Our own experience has led us to believe that this massage is so much more effectively carried out through a thoracotomy incision than in any other way that the surgeon operating within the abdomen should not expend precious time in attempted massage of the heart from below the diaphragm. In the panel discussion at the September meeting of the American College of Surgeons this question was put to the panel by one of us. The four members of the panel were unanimous in their opinion that immediate thoracotomy should be carried out despite the fact that the abdomen has already been opened.[17] However, it is only fair to state that others report successful cardiac massage carried out through an incision in the diaphragm. Skin preparation, sterile gloves and instruments are not imperative unless immediately available. The single most necessary instrument is a knife. Thoracotomy may be carried

out through the fourth or fifth interspace, intercostal incision without rib resection being employed. The costal cartilage above and below such an incision may be divided about 3 cm. lateral to the margin of the sternum to avoid injury to the underlying internal mammary artery. We have recently learned of a patient successfully resuscitated with subsequent exsanguination into the left pleural cavity from an unrecognized injury to the internal mammary artery.[18] Such an injury might escape recognition at the outset since active bleeding would not occur immediately if the circulation had been arrested. In elderly patients bandage scissors or an osteotome may be required to cut through calcareous costal cartilages if a rib cutter is not available.

The heart is grasped with the entire hand, and regular, moderately forceful massage is carried out at a rate of about 50 or 60 compressions a minute. A large heart may require bimanual pumping to displace an effective amount of blood into the aorta with each squeeze. In our 4 cases in which spontaneous cardiac rhythm was resumed after massage, we were impressed with the fact that the technic and rate of cardiac massage were not as important as the speed with which the massage was instituted. The resumption of cardiac action has usually been prompt if it is to occur at all, but isolated examples of prolonged cardiac massage with eventual success have been reported. Some authors[12, 13] propose a much faster rate of manual massage, but a rate of 50 or 60 compressions a minute has seemed feasible to us. The surgeon's hand becomes fatigued readily so that an alternate should be available. It has been demonstrated that such manual pumping of the arrested heart is capable of producing a discernible systolic blood pressure between 70 and 80 and even a detectable peripheral pulse.

Restoration of the Normal Heart Beat

When the heart has been exposed by thoracotomy, the surgeon may find that the ventricles are motionless, fibrillating or, least commonly, beating slowly and ineffectually. In each instance, the clinical picture of a suddenly arrested pulse and respiration with absence of blood pressure will be identical. Blalock[19] and others have urged that the pericardium be incised immediately lest ventricular fibrillation escape detection. We have not encountered ventricular fibrillation, although in some series the incidence has been reported to be as high as 50 per cent. The pericardium was opened in Case 1, but it is our opinion that immediate massage of the arrested heart should be begun and the pericardium opened subsequently. In 4 of our 5 cases, the heart was at a complete standstill. In the most recent case, the ventricles were contracting slowly and feebly at a rate of about 20 a minute. Simultaneous thoracotomy and the injection of various cardiac stimulants, including epinephrine, have been proposed. It seems desirable to us, however, to defer employment of drug therapy until the state of the heart muscle has been identified after the chest is opened and to make certain that the initial cardiac massage has not resulted in the spontaneous resumption of efficient cardiac rhythm.

If the heart does not begin to beat within a few minutes of the institution of manual massage, or if the restored beat appears quite feeble, 0.2 cc. of a 1:1000 solution of epinephrine may be injected directly into the left ventricle. This dosage can be repeated safely once or twice if necessary. There appears to be no question whatever that epinephrine has often been responsible for the resumption of heart beat when other measures, including massage, have failed.[7] Both the strength of such an epinephrine solution and the site of injection into the heart are topics of debate. A number of authors prefer a more dilute solution and are hesitant about introducing the solution into the left ventricle lest such concentrated epinephrine have too speedy access to the coronary circulation.

The intracardiac injection of procaine or procaine amide (Pronestyl) has been advocated in other cases to lessen myocardial irritability and thus to prevent or correct ventricular fibrillation. In our last 2 cases, procaine amide was injected intravenously in repeated small doses (150 mg.) some time after the heart had quickly resumed spontaneous rhythm in response to manual massage, and electrocardiograms taken in the operating room during the next several hours revealed ventricular irritability. Recent case reports[20, 21] sound a note of caution to suggest that the toxic properties of procaine or procaine amide may outweigh its possible advantages. Fatal ventricular fibrillation has actually followed its use. Our cardiologists believed that it was proper to give the drug in our last 2 cases because of the existence of ventricular irritability, but procaine would not at present be employed in any form initially without specific indications for its use.

When ventricular fibrillation is encountered, immediate manual massage is just as urgently required as with a completely arrested heart, since cerebral and cardiac anoxia must be corrected as soon as possible. There is no immediate need of defibrillation. The existing fibrillation is often due to hypoxia of the heart muscle itself, which may be corrected by massage alone, and in a number of cases normal cardiac rhythm has been resumed after massage. Stevenson,[2] in his extensive series, reported a 10 per cent incidence of ventricular fibrillation in these collected cases of cardiac arrest, about half of which were successfully defibrillated. The surgeon's hand acts as the effective pump for the circulation while the necessary apparatus for electric defibrillation is being set up.

Cardiac standstill of the fibrillating ventricle can be accomplished by an electric defibrillator. Gibbon[22] and Johnson and Kirby,[12, 13] as well as other

authors, have expressed their conviction that some type of defibrillator should be part of the available equipment in all operating rooms. An electric shock is administered to the entire heart, as a consequence of which cardiac standstill is accomplished. Subsequently, regular spontaneous cardiac rhythm may be resumed. Cardiac massage must, of course, be maintained in the interval. Electric defibrillators recently described are not elaborate and could be installed in small hospitals. At the recent annual meeting of the American College of Surgeons, an extremely simple device for electric defibrillation was demonstrated by Buckley, Keown and Ruth.[23]

Their device consists of two electric cords, 150 cm. in length, leading from an ordinary wall plug to two copper electrodes, 8 by 5 cm. in width and about 2 mm. thick. These investigators, on the basis of their great experience with cardiac arrest at the Hahnemann Hospital, suggest that one or more electric shocks be administered to the fibrillating heart by means of a copper electrode placed on the anterior and posterior surfaces of the heart. A nurse, standing at a safe distance from the operating-room table, to minimize the hazard of anesthetic explosion, then makes connection from this plug to ordinary wall current (110 volts, 60 cycles, alternating current) while the electrodes are placed in contact with the two surfaces of the heart. The entire body of the unconscious patient may jerk convulsively. The current is immediately disconnected after the surgeon has counted, "One, two, three." Dr. Charles Bailey has employed such an electric device for defibrillation. In his experience, effective electric shock to the heart adequate to promote cardiac standstill has been achieved. If a single shock does not result in the cessation of ventricular fibrillation, it may be administered one or several more times. The electrodes applied to both surfaces of the heart are insulated to minimize the possibility of contact between the electric current and the surgeon's hand. In Bailey's opinion the expense of such an apparatus is minimal, the degree of electric shock to the heart effective, and the danger negligible.

At the Salem Hospital we have had such a simple electric device constructed at a cost of about $1.00. It is now included in our routine equipment. It is obvious that small community hospitals are not in a position to purchase expensive apparatus for defibrillation of the heart, but that described is simple, safe and effective. The method of resuscitation by external electric stimulation recently described by Zoll[24] may prove to be an important advance in the treatment of cardiac arrest.

Accessory Treatment

Ten or fifteen degrees of Trendelenburg position promotes the flow of oxygenated blood to the critical centers of the brain. Manual occlusion of the thoracic aorta may further aid the diversion of blood to the head.[25] Rapid blood transfusion may be injected directly into the adjacent aorta and should be administered whenever excessive blood loss may have been a factor in the occurrence of cardiac arrest.

Summary and Conclusions

Five cases of cardiac arrest occurring in anesthetized patients in the operating room of a community hospital are reported.

Four of these cases occurred within a recent six-month period. It is believed that other earlier cases were not recognized.

The patients in the 2 most recent cases made a complete recovery after thoracotomy and cardiac massage.

Our mortality is therefore 60 per cent, but our success in the last 2 cases has emphasized the value of alertness to and provision for this operating-room disaster.

A "cardiac-arrest" kit should be immediately available in all operating rooms. A simple electric device for defibrillation of the fibrillating heart is described and should be included in such a "cardiac-arrest" kit.

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THE ORAL USE OF FAT EMULSIONS IN CLINICAL MEDICINE*

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CLINICIANS have long been interested in the adequate nutrition of their patients. Illnesses involve the whole patient rather than isolated systems, and general nonspecific therapeutic measures must frequently be added in the treatment of the whole patient as well as the specific clinical condition. Anorexia is a common complaint in illness, leading to inadequate caloric intake that may be of prolonged duration. In a prolonged caloric deficiency, ingested proteins are deaminated and metabolized directly for their caloric content rather than made available for protoplasmic regeneration. Thus, if caloric equilibrium is not attained, even supplemental protein feedings are used as expensive sources for extra calories rather than for body rebuilding as intended. It is well known that chronic undernutrition prolongs illness and convalescence, increases surgical risk and morbidity, and may minimize the favorable extent of an expected therapeutic response. Prolonged caloric deficiency in healthy men will also lead directly to a variety of psychosomatic symptoms, including irritability, nervousness, excessive fatigue, physical and mental exhaustion, insomnia, anorexia, and even transient psychotic behavior. One can prevent or treat such symptoms by supplying the missing calories.[1] Similar, nonspecific psychosomatic symptoms are frequently noted in sick patients, especially in diseases associated with hypermetabolism. In neoplastic diseases, these nonspecific effects of chronic malnutrition may be of greater importance than the local infiltrative process, and often markedly reduce the patients' physical endurance to withstand adequate surgical, radiation or chemical therapy.

Oral caloric supplements of many varieties have been used to increase an inadequate food intake, both qualitatively and quantitatively. An ideal preparation should be acceptable and palatable, be easily available without extensive preparation, contain a maximum of utilizable calories in a minimum volume, and be free of secondary effects upon the patient.

Carbohydrate and protein supplements for use in this problem have been thoroughly explored and have been given successfully to infants, children and adults. The major objection to their administration is the large bulk necessary to administer a significant number of extra calories to a patient whose oral intake is already markedly reduced, and the tendency to excessive fermentation within the gastrointestinal tract when they are given in large amounts, with resulting diarrhea. In general, carbohydrate and especially protein supplements are well accepted, and earlier palatability problems have been reduced to insignificance.

Fats have heretofore enjoyed little success as food supplements even though they potentially offer more calories per unit volume, containing 9 calories per gram. Pure solid and liquid fats are unpalatable, and prolonged high-fat diets are soon rejected by the patient after initial earnest attempts to consume them. If a liquid fat is finely emulsified in water, a stable dispersion of the fat is obtained in a watery vehicle that is potable and palatable,

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making available a large amount of extra calories in a form that can be administered easily.

Study of the absorption of oils in the rat[2] demonstrated that emulsions of oils in water, with either purified soybean phosphatide or refined gelatin solution as emulsifiers, were unstable in the stomach, breaking down within an hour; the absorption of emulsified and unemulsified oils was similar after stomach intubation, and the absorption rate of intubated oil was not affected by the presence of large amounts of soybean phosphatide or Tween 80 (polyoxyethylene sorbitan mono-oleate).[3] Stable emulsions of edible oils and mineral oil in gelatin solution were better absorbed than their unemulsified parallels only when intubated directly into an isolated intestinal segment from which gastric, biliary and pancreated secretions were excluded.[3] On the basis of these studies, it was believed that an emulsion of oil in water that could maintain its finely divided dispersion in the presence of gastric, biliary, pancreatic and intestinal secretions would probably be better absorbed than its unemulsified counterpart. However, to date, no emulsion that could remain stable under these conditions has been prepared. Thus, the emulsification of the oil renders it potable and palatable, enabling its easy administration for protracted periods, but emulsification per se has little effect upon the rate of absorption of the oil from the gastrointestinal tract.

Experience with the use of an oral fat emulsion under clinical conditions has already been reported.[4] This emulsion consisted of 40 per cent peanut oil in 10 per cent dextrose or sucrose, with 2.2 per cent emulsifiers. It contains 7.3 milliequiv. (172 mg.) of sodium per liter and 8.0 milliequiv. (312 mg.) of potassium per liter. The particle size of the oil dispersion averaged 0.5 to 1.0 micron and remained stable for months at room temperature. It remained fluid after chilling to 5°C., and was easily administered by glass, tube feeding or nippled bottle. Since an emulsion has the physical characteristics of its external watery phase, it mixed easily with watery solutions and dissolved water-soluble compounds. Its caloric value was 4 calories per cubic centimeter. The initial experience was obtained in 33 healthy adult volunteers and 98 unselected adult patients hospitalized for a variety of medical and surgical complaints. Approximately 75 per cent of these subjects drank adequate amounts of the emulsion for periods deemed adequate for observation, ranging from five to a hundred and fifty days. Of these, all the healthy adults who tolerated the material over the time studied gained and retained significant weight, and 80 per cent of the hospitalized patients gained significant weight. The average rate of gain noted in the healthy adults was equal to the amount of extra fat that they had ingested. However, in contrast, the hospitalized adults gained weight at twice this rate. This observation was suggestive of a protein-sparing action of the supplementary fat in these patients, who had previously been in apparent negative nitrogen balance. The mechanism of this protein-sparing action, confirmed in balance studies on human volunteers, was to effect a caloric equilibrium, allowing the ingested amino acids in the protein to be utilized as such, rather than to be deaminated and consumed for caloric purposes.

The 25 per cent of the subjects unable to tolerate the emulsion complained primarily of gastrointestinal symptoms, including distention, epigastric discomfort, nausea, vomiting and abdominal cramps. Complaints of unpleasant taste were frequent, but rarely sufficient to cause the subject to discontinue the study. The gastrointestinal symptoms were found to occur in many of those who limited their dietary intake of fats normally, although no evidence of organic gastrointestinal disease could usually be obtained. Preliminary doses of 30 to 60 cc. of emulsion were found to minimize unpleasant digestive reactions.

Since this clinical study demonstrated a potential usefulness of oral fat emulsions as a dietary supplement, it was thought that a more extensive clinical study might demonstrate the clinical indications and contraindications for its use, and might elucidate clinical conditions in which it would be therapeutically useful. For this purpose, 102 further patients were studied, which, when combined with the original group of 98, gave a total of 200 subjects to whom the emulsion was administered as a dietary supplement. The original emulsion* as well as a newly developed chocolate-flavored emulsion of 40 per cent peanut oil in 10 per cent sucrose was used in a small comparison study as well to determine the differences in palatability and ease of acceptance.

The emulsions were usually drunk from glasses, but were also administered to 7 patients by gastric tube, to 2 by gastrostomy and to 2 by jejunostomy. It was given either as a single drink between the evening meal and bedtime or in three or four small doses during the day, usually 30 to 120 cc. with each meal and a similar dose in the evening. Observations were limited to patients who took at least 125 cc. of emulsion each day for at least five days.

The summary of the observations of this study is given in Table 1. In general, the emulsion was tolerated by 77 per cent of the entire group. Of this 77 per cent, a total of 70 per cent of patients gained significant weight. Markedly accelerated weight gains were noted on numerous occasions, which greatly aided the over-all treatment of the illness. The following case reports help to enumerate certain clinical conditions in which the use of

*The original emulsion is now available as "Lipomul-Oral," prepared by the Upjohn Company, Kalamazoo, Mich. The chocolate-flavored emulsion was kindly supplied by Earl Burbidge, M.D., medical director, Upjohn Company, Kalamazoo, Mich.

the emulsion as a caloric supplement was of particular benefit.

Case Reports

Case 1. A 72-year-old man was admitted to the hospital because of marked weight loss and epigastric pains that were demonstrated to be secondary to a gastric ulcer. The ulcer was thought to be malignant because of its large size, although other radiologic criteria for malignancy were absent. In addition to the usual dietary and anti-ulcer regimen, he was given the oral fat emulsion as an evening supplement, taking 250 cc. each night easily, with a marked response in weight gain and disappearance in symptoms. Obvious healing of the ulcer was noted within 1 month, and complete disappearance 2½ months after the beginning of treatment. The total weight gain was 22 pounds in 93 days, during which he consumed 17,750 cc. of the emulsion. Approximately half the weight gain was attained in the 1st month of dietary supplementation.

This favorable experience — a symptomatic response as well as a weight gain — with the emulsions on peptic ulceration of the stomach and duodenum was found in 19 out of 25 cases treated. This is not unexpected, since a high-fat diet has long been used for the dietotherapy of peptic ulceration.

Case 2. A 32-year-old woman who was admitted to the hospital because of the classic symptoms of thyrotoxicosis, was treated with propylthiouracil in preparation for surgery. Oral fat emulsion was added to the high-calorie diet for a 20-day period immediately before operation. During this time while the basal metabolic rate fell only from + 59 to + 25 per cent, a weight gain of 6.6 pounds was noted, concurrent with the administration of 3000 cc. of emulsion.

A total of 7 thyrotoxic patients were studied, 6 of whom demonstrated this favorable response, which must be deemed a helpful adjunct to preoperative preparation. A high-calorie food supplement that is easily assimilated by the thyrotoxic patients, who may frequently complain of anorexia rather than polyphagia, is of great potential use in the medical and surgical management of these cases.

Case 3. A 46-year-old man was admitted to the hospital because of fever and a 20-pound weight loss secondary to a carcinoma of the right-upper-lobe bronchus. The patient was given a total of 750 cc. of the emulsion over a 7-day period, during which the only other therapy was an antibiotic regimen in preparation for surgery. He gained 4 pounds, noted a feeling of well-being, and withstood pneumonectomy easily.

The emulsion has been quite useful in the preoperative preparation of patients with resectable cancer. Weight loss can be halted and often reversed, and it may be inferred that, a negative nitrogen and caloric balance having been reversed, wound healing is more likely to be complete and postoperative morbidity diminished.

Case 4. A 28-year-old man was readmitted to the hospital because of fever, chills, cough and a 15-pound weight loss secondary to an exacerbation of documented Hodgkin's disease of 4 years' duration, with generalized lymph-node enlargement as well as a right-lower-lobe infiltrate and secondary pleural effusion. He received an intensive course of irradiation to the right inguinal lymph nodes as well as a course of nitrogen mustard therapy, with a good response. He was given 7600 cc. of the emulsion as an evening supplement over a 50-day period, including the period of active therapy, and gained 6 pounds despite persistence of lymphadenopathy and pulmonary and hepatoliensal involvement, as well as marked anorexia during the mustard therapy.

Table 1. *Responses of Hospitalized Patients to Dietary Supplements with Oral Fat Emulsions.*

Major Illness	Cases of Good Tolerance with Weight Gain	Cases of Good Tolerance without Weight Gain	Cases of Poor Tolerance with Weight Gain	Cases of Poor Tolerance without Weight Gain	Total No. of Patients
Peptic ulcer	19	2	—	4	25
Nontuberculous pulmonary disease	15	5	—	—	20
Cardiovascular disease	8	4	—	2	14
Pulmonary tuberculosis	6	1	—	7	14
Rheumatoid arthritis and Reiter's syndrome	6	4	2	1	13
Metastatic cancer, source undetermined	4	5	1	—	10
Lymphoma	1	3	—	5	9
Gastrointestinal-tract cancer	2	5	—	1	8
Thyrotoxicosis	6	—	—	1	7
Pulmonary cancer	3	3	—	1	7
Uremia and nephrosis	2	1	1	2	6
Grouped neurologic and psychiatric conditions	2	1	—	3	6
Ulcerative colitis	4	1	—	—	5
Psychoneurosis	1	—	—	4	5
Cerebrovascular accident	2	3	—	—	5
Undiagnosed disease	4	—	—	—	4
Blood dyscrasia, including leukemias	1	1	—	2	4
Infectious mononucleosis	3	—	—	—	3
Peripheral vascular disease	2	1	—	—	3
Liver cirrhosis	2	—	—	1	3
Achalasia and cardiospasm	2	—	—	1	3
Lupus erythematosus	1	2	—	—	3
Chronic pancreatitis	2	—	—	1	3
Combined gynecologic conditions	2	—	—	1	3
Combined endocrinologic conditions	3	—	—	—	3
Combined gastrointestinal conditions	3	—	—	—	3
Miscellaneous conditions	1	1	—	1	3
Combined urologic conditions	—	1	1	—	2
Extrapulmonary tuberculosis	1	1	—	—	2
Prostatic cancer	—	—	—	2	2
Hiatus hernia	—	—	1	1	2
Totals	108	45	6	41	200

The fat emulsion seems peculiarly well suited to subjects undergoing irradiation or nitrogen mustard therapy for inoperable cancer, enabling them to minimize weight loss or even to maintain their weight despite the greatly diminished food intake frequently seen during these therapies. The conservation of the physical strength of the patient may facilitate a complete course of treatment, which otherwise might be interrupted or never completed because of progressive debilitation.

Case 5. A 35-year-old man was admitted to the hospital because of right-lower-quadrant pain associated with a mass. Laparotomy disclosed a metastatic retroperitoneal adenocarcinoma, of undetermined origin. The postoperative course was complicated by a wound infection, which progressed to a large sinus that drained moderate amounts of purulent material, associated with a progressive weight loss of 25 pounds in the first 3 postoperative months. He was then given antibiotics and fat emulsion, of which he ingested 20,310 cc. during the next 55 days. His weight loss was reversed to a 3.5-pound weight gain, despite the persistence of the wound infection. He also noted a feeling of well-being, increased strength and an increase in appetite. He was then discharged from the hospital under home-care supervision, after instruction in changing his own dressings and administering his own medications.

This case illustrates the importance of supportive therapy in patients with metastatic cancer. Rather than a hopeless therapeutic problem, much comfort and happiness can be offered them throughout most of the duration of their illness. Frequently, as in this case, although vital functions remain unaffected and the systemic symptoms of the cancer are prominent, they may respond to such an extent as to be able to return to and enjoy their families for whatever limited period is possible. Thus, the patient's morale is strengthened and the economic drain upon his finances to pay for a protracted and hopeless hospitalization halted, if only transiently. Of 10 patients with metastatic cancer given Lipomul as a supplement, 4 gained weight. Of 30 patients with cancers of all types treated, 10 gained weight.

Case 6. A 70-year-old woman was admitted to the hospital because of oliguria secondary to a lower-nephron-nephrosis syndrome after shock during a cholecystectomy. She received 1725 cc. of the emulsion, practically her only nutriment, during the 1st hospital week, while receiving artificial-kidney blood dialysis. This fat was tolerated well despite uremia, and, by minimizing endogenous protein catabolism, probably contributed to the successful outcome of the treatment.

The usefulness of a high-fat, low-protein and controlled-electrolyte diet for the treatment of acute and chronic uremia introduced by Borst[5] has been adequately confirmed.[6] In this respect the emulsion may be considered as therapeutically indicated to attain caloric equilibrium and thus to minimize protein catabolism for caloric needs, whether from an exogenous or an endogenous source. Thus, the production of nitrogenous waste compounds and concomitant sulfates and phosphates, as well as the liberation of potassium, is reduced to a minimum.

Case 7. A 41-year-old man was admitted to the hospital because of dysphagia, frequent regurgitation of food and a 25-pound weight loss, which was demonstrated to be due to achalasia involving the esophagus. Without specific treatment he was placed on a high-calorie, bland diet, which was supplemented with 1120 cc. of fat emulsion given 3 or 4 times a day, a total of 39,600 cc. in a 90-day period, which he retained very well. During this time he gained 5 pounds.

This case illustrates the ability of the emulsion to supply an adequate number of calories to patients who, because of mechanical or neurologic difficulties localized to the mouth, pharynx or upper gastrointestinal tract, are unable to ingest sufficient solid and liquid food to maintain caloric and nitrogen balance. Two 250-cc. glasses of emulsion contain approximately 2000 calories, which will supply nearly the entire caloric need of the day for the average patient.

Case 8. A 25-year-old man with a long history of intractable ulcerative colitis, previously treated by an ileostomy, was admitted to the hospital because of a recurrence of severe colitis in his isolated colon. A colectomy was performed and he was placed on 200 cc. of fat emulsion a day on the 8th postoperative day, taking a total of 12,000 cc. in 60 days, with a total weight gain of 17 pounds.

This case, as was observed in 4 of the 5 patients with ulcerative colitis treated, typified the gratifying response to adequate caloric supplementation in subjects with wasting diseases that responded fairly well to medical or surgical therapy. The rate of weight gain in these subjects was rapid and often beyond that ordinarily experienced with the most favorable clinical responses. Although the only group designated as demonstrating a successful result in this study was limited to patients who had gained weight after drinking adequate amounts of these fat emulsions for at least a minimum observation period, mention should be made of a number of patients with persistent weight losses secondary to their wasting illnesses, in whom this weight loss was minimized or stabilized. Since there was no gain in weight these cases are not considered successful responses to the emulsion.

Discussion

These case reports serve to illustrate the wide variety of clinical conditions in which the emulsions were used successfully as caloric supplements. The primary indication for their administration is a caloric deficit of any cause. They have demonstrated particular therapeutic indications in the treatment of peptic ulcer and acute and chronic uremic states. They have also been valuable in the treatment of conditions involving mechanical, neurologic or psychiatric impediments to the ingestion of food localized to the mouth, pharynx or esophagus that necessitate small volumes of fluid feedings. These emulsions have been effective adjuncts in the preoperative and postoperative dietotherapy of certain wasting conditions amenable to surgery, including thyrotoxicosis. Finally, they have greatly assisted in the supportive therapy of the patient with nonoperable cancer.

The most serious difficulty encountered with the use of the emulsion was the significant incidence of intolerance to the fat, especially manifested by symptoms localized to the gastrointestinal tract, including sensations of epigastric discomfort or distention, nausea, vomiting and abdominal cramps or pains. When the emulsion was used as an evening supplement after the last scheduled meal, anorexia was rarely encountered. The taste of the unflavored emulsion was not appealing though it was accepted by the great majority of all patients for whom it was prescribed. The new chocolate emulsion was found much more palatable and therefore preferable. Only 2 out of the 50 subjects who took the chocolate emulsion were unable to drink adequate quantities because of unpalatability. In 4 cases, patients unable to tolerate as little as 30 cc. of the unflavored emulsion, because of unpleasant flavor or moderate gastrointestinal symptoms, were able to take up to 240 cc. of the chocolate-flavored preparation in divided doses each day. Each of 12 subjects given both types of emulsion over extended periods preferred the chocolate. However, the rate of tolerance of the emulsions, flavored or plain, was essentially the same: approximating 75 per cent. Therefore, the cause for reactions to the emulsion lies in the fat content. It is noteworthy that approximately 50 per cent of the subjects who were intolerant to the emulsion were also intolerant to large amounts of dietary fats. A minor complaint encountered with some frequency was a fatty aftertaste. This was eliminated by the eating of a dry cracker immediately after drinking.

Clinical contraindications appeared early in the study and were limited to diseases of the gastrointestinal tract. Biliary-tract calculi constitute an absolute contraindication to the use of the supplements. Since fat inhibits gastric motility and secretion, it should be used with caution in incomplete and mild gastric obstruction, and not at all in severe gastric obstruction. It was found to be useless as a dietary supplement in patients with steatorrhea secondary to pancreatic deficiency, an observation confirmed by unpublished observations in children with chronic cystic fibrosis of the pancreas. In 1 adult with steatorrhea, a good effect was noted when exogenous pancreatic lipase was added to the diet. It must be assumed that its use would be similarly limited in other cases of steatorrhea unless the metabolic defect could be remedied.

If a diet adequate in carbohydrate and protein and complete in vitamins is ingested, there is no contraindication to the use of the emulsion in patients with hepatitis or cirrhosis of the liver, since adequate to large amounts of dietary fats have been demonstrated to be therapeutically indicated in the dietotherapy of these cases.[7, 8] The relation of dietary fats to atherosclerosis is now the subject of an intensive investigative effort. Since this supplement is usually given for a limited period estimated in weeks until a normal diet is attained, no effect upon atheroma formation is likely.

In conclusion, these clinical observations demonstrate that oral fat emulsions were potable and palatable when used as dietary supplements in adult medical and surgical illnesses in which adequate nutrition has not been obtained. They contain a large number of available calories in a minimum volume of liquid and effectively supplement deficient diets. Thus, a return to positive caloric and nitrogen balance could be effected easily and rapidly, resulting in significant weight gains among 70 per cent of patients able to tolerate these drinks. However, 23 per cent of the unselected patient population were unable to tolerate amounts of emulsion sufficient to make available a significant number of calories. This minimum quantity was arbitrarily selected as 125 cc. or 500 extra calories obtained from the emulsions. It seems probable that future developments in the preparation of fat emulsions will reduce the incidence of gastrointestinal intolerance.

Summary and Conclusions

Emulsions of 40 per cent peanut oil in 10 per cent dextrose or sucrose, both unflavored or with added chocolate flavoring, with a caloric equivalent of 4 calories per cubic centimeter, were administered to 200 unselected adult patients in need of extra calories. These patients were hospitalized for a wide variety of medical and surgical illnesses. One hundred and fifty-three of these subjects easily tolerated 125-cc. to 750-cc. daily doses of emulsion averaging approximately 200 cc. per day, administered usually by mouth, and also by tube feedings; 108 gained from 1 to 25 pounds over periods of study ranging from five to a hundred and fifty days. The chocolate-flavored emulsion was more acceptable than the unflavored and was tolerated slightly better. These fat emulsions were particularly useful in the treatment of peptic ulcerations, acute or chronic uremic conditions, in the caloric supplementation of wasting diseases correctible by surgery, such as thyrotoxicosis and localized cancers, in the supportive therapy of the patient with nonoperable cancer and in complementing fluid-feeding and tube-feeding regimens.

The emulsions should not be administered to patients with biliary-tract calculi or severe gastric retention.

The common symptoms of intolerance to the emulsions, experienced by 23 per cent of the total group, were sensations of epigastric distention or unpleasant heaviness, anorexia, nausea, vomiting or abdominal pains. These symptoms were minimized by the use of small introductory doses of 30 to 60 cc. of the emulsions, followed by gradual increments.

The caloric gains obtained resulted in significant therapeutic contributions to the clinical care of the patients.

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THROMBECTOMY IN VOLKMANN'S CONTRACTURE

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ARTERIAL thrombectomy is a previously untested treatment for Volkmann's contracture. A review of the literature failed to reveal any earlier employment of the procedure. Griffiths[1, 2] reported segmental arteriectomy and described embolectomy in patients who are fibrillating, but he did not mention thrombectomy at the site of injury in cases of contracture. Foisie[3] advocated arteriectomy for "stubborn" cases, but he did not consider thrombectomy.

Orthopedic and surgical textbooks properly emphasize prophylaxis against Volkmann's contracture rather than treatment. Most conservative therapeutic measures — for example, fasciotomy, sympathetic block and removal of splints — have been disappointing and inadequate in combating fully developed contractures.

Principles of treatment seem to be confused further by controversy over etiology of this condition.[4] There have been two points of view about the relative importance of the roles of the arteries and of the veins in its development. French[5] and British[1, 2, 6-8] authors have devoted most attention to arterial changes. Early American opinion concerned itself primarily with pathology in the veins. Emphasis on the venous changes here in the United States is a natural consequence of the experimental work of Brooks[9] on dogs. His research seemed to establish the primary role of venous thrombosis in this unfortunate complication of fractures and other injuries. John B. Murphy, on clinical grounds, had previously considered venous changes as the primary ones to fear. In 1942 Foisie indicated a changing American concept — he blamed "nearly complete ischemia produced by arterial spasm of the main artery and the collateral circulation."

In the case reported below, a thrombus was removed from the brachial artery of a child with a contracture. The result has been encouraging; it may also lead to increased understanding of the pathology of this deformity.

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Case Report

S. M. B., a 3-year-old girl, sustained a supracondylar fracture of the right humerus on May 12, 1950. The fracture was reduced approximately 1 hour later, and the arm placed in flexion in a molded plaster splint of the sugar-tong variety. The patient's father, a physician, became alarmed about 4 hours later when he noticed that the radial pulse was absent and that the hand was slightly swollen and extremely cold. The child complained of great pain. Involuntary flexion of the fingers and wrist was progressive.

In a neighboring city the arm was removed from the splint and placed in extension. The surgeon who was consulted elected to make an incision from the arm into the forearm across the antecubital space. He exposed and incised the lacertus fibrosus. The brachial artery was found to be constricted, hard and pulseless. A perivascular stripping performed at that time was thought to cause the artery to dilate somewhat and even to bring about a feeble pulsation in the radial and ulnar arteries. The hand nevertheless remained cool and white.

Once again the father's dissatisfaction with the status of the hand made him seek aid. The child's arm was placed on a pillow so that she might be moved approximately 90 miles to Seattle. At the time of the initial examination, nearly 20 hours after injury, the hand was cold and white and was found to be drawing upward in volar flexion. There were no pulses at the wrist. Voluntary motion was completely lacking; this may have been due in part to failure of the child to co-operate because of pain and apprehension. Passive extension of the hand caused her to cry out in pain. The incision over the antecubital space was somewhat edematous and slightly ecchymotic, but did not appear to be the site of any major hemorrhage.

The patient was immediately taken to the operating room, where she received nitrous oxide and ether anesthesia and a right stellate ganglion block, 2 per cent procaine being used. During the period of preparation, the color of the hand, which was left undraped, did not improve. The incision made a few hours before was reopened. The lacertus fibrosus had been sectioned completely. Lying in the bottom of the wound was the constricted brachial artery. Pulsations were visible only in the proximal portion of the artery; distally it was rigid and immobile. Anterior to the fracture, which could be felt through the brachialis muscle, the artery appeared to be contused and was merely a shrunken cord, which felt extremely hard. This point lay 2 cm. proximal to the bifurcation of the brachial into the radial and ulnar artery. No pulsations were palpable or visible in the proximal portions of the two principal branches, which were soft and compressible, but seemed to be completely collapsed. The muscle fibers evident in the incision were rather pale; they did not

appear to be the site of any hemorrhage. The veins were soft and collapsed.

It seemed likely that there was a thrombus at the site of greatest trauma to the artery. For that reason a transverse incision was made through the anterior wall of the brachial artery 1 cm. proximal to the most evidently contused section of the vessel. The artery did not bleed when first opened. Gentle compression immediately distal to the incision caused extrusion of a clot that measured 7 by 2 mm. and represented a cast of the vessel lumen (the pathologist reported both thrombus and adherent endothelium).

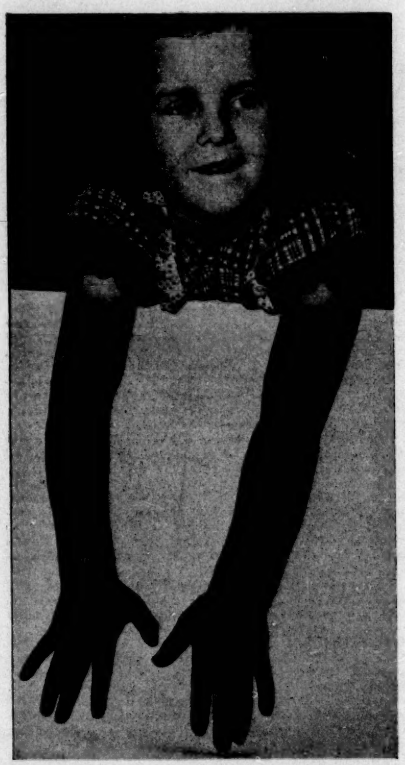

FIGURE 1. *Status of Forearms and Hands Eighteen Months after Thrombectomy. There is some atrophy on the right.*

A No. 25 needle was inserted into the vessel 5 cm. proximal to the incision. Heparin solution (1:1000) was injected with a syringe, as suggested by Freeman.[10] Within 1 minute blood had begun to escape from the incision in the vessel. Free bleeding was permitted for 2 minutes. A single everting mattress suture of No. 00000 Deknatel was then used to close the vessel.

As warm saline solution was sprayed over the operative field the distal end of the brachial artery appeared perceptibly to dilate. Soon a pulsation was visible and palpable in the distal brachial artery and in its 2 primary branches, the radial and the ulnar. The hand became pink and somewhat warmer. Bleeding from the operative wound in the artery did not cease for approximately 10 minutes. No effort was made to establish complete hemostasis by further suturing. Instead, gentle pressure with a pledget was made from time to time until the bleeding gradually stopped.

The wound in the skin was approximated loosely with interrupted silk sutures. The patient returned to her bed with the arm on a pillow and a 3-pound weight applied to the forearm with skin traction. The radial pulse was palpable at the conclusion of the procedure.

Traction was employed for the next 3 weeks. Successive x-ray examinations of the fracture showed gradual improvement in the alignment of the fragments. Pulsations of the radial artery at the wrist have continued to be present throughout the entire convalescence, now 27 months. The patient has been encouraged to use her hand and forearm but regrettably has not had any active, orthodox physiotherapy. She uses her hand normally at play, in feeding herself and in other activities. All fingers flex and extend freely. When she was last seen there was some atrophy of the entire hand, most noticeable in the volar digital pads at the ends of the fingers, which were tapered, rather than rounded and full. There is an unfortunate contracture in the linear scar originally made over the antecubital space. Thus far, recommendations for plastic surgery to the contracture have not been acceptable to the parents. The patient has a forearm and hand that are not absolutely normal but are serviceable to her and that continue to improve (Fig. 1).

DISCUSSION

This case provides a challenge to re-examine current surgical thought concerning Volkmann's contracture, and to recall that Volkmann, in his original discussion of the deformity in 1871, referred to it as an "ischemic" contracture. Our experience and that of British investigators in World War II tend to re-emphasize the importance of arterial obstruction as opposed to venous thrombosis.

The British authors[11] agree that an actual thrombosis in the major arteries is concerned at the time of injury. Their investigations involve the use of arteriography to demonstrate arterial occlusion in the vessels contiguous to the site of the fracture. It must be admitted, however, that all the arteriograms were made three weeks or more after the injuries. The patients had been evacuated after bombardment to so-called fracture centers. The fractures had been splinted at the time of injury and then necessarily could not be finally appraised until after evacuation. Permanent atrophy and contracture, which characterize this unfortunate condition, were established by the time investigation was begun.

We were unaware of the English inquiry into the matter until after the operation described in this paper. It is our opinion that the findings in the single case reported above tend remarkably to conform to the early stages predicated by the English authors in their discussions and to confirm the statements made by Griffiths[1] in his Hunterian Lecture when he insisted that arterial obstruction is a prime factor in the development of the contracture.

All research into this problem has run into a paradox. Ligation of the arteries to a limb or to a group

of muscles does not produce histologic changes characteristic of Volkmann's contracture, even when the circulatory deficit is so extreme as to cause gangrene. Brooks'[9] experiments led him to the belief that massive thrombosis was essential. He visualized extensive venous and muscular trauma occurring in fractures as the prerequisite to edema and reflex arterial spasm. Griffiths[1, 2] disagreed; he suggested that thrombosis or spasm in principal arterial trunks must be accompanied by widespread arteriolar and capillary constriction. He believed that the histologic changes observed in established instances of Volkmann's contracture were different from the histologic changes produced by Brooks' experiments in the dog. Foisie[3] likewise insisted that the production of a muscular sequestrum of gelatinous muscle tissue in the early stages and eventual fibrosis could come about only by widespread arterial and arteriolar constriction. He postulated a temporary complete occlusion of arteries and collateral vessels of just sufficient duration to result in necrosis of the affected muscle tissue but without loss of the entire limb.

Restoration of circulation before irreparable damage has occurred becomes a logical goal if one follows these precepts. Sympathetic block or sympathectomy is of value in dilating both the main arterial trunk and collateral branches. Leriche[12, 13] and Foisie[3] believe that segmental arteriectomy may be expected to eliminate the sources of reflex spasm in collateral vessels even though it sacrifices the main artery in the affected part.

Conclusion

An isolated experience with thrombectomy substantiates the view that arterial occlusion is of tremendous significance in Volkmann's contracture. A direct attack on the artery is advisable in the relief of acute devastating vascular constriction. In this case it was possible to restore a functional arterial lumen as well.

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HEMIGASTRECTOMY COMBINED WITH RESECTION OF THE VAGUS NERVES*

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MANY surgeons have come to consider subtotal gastrectomy the procedure of choice for duodenal ulcers demanding elective operative therapy. The results of this maneuver are gratifying in most cases. There are, however, two primary causes of dissatisfaction, which although relatively infrequent are sufficiently serious to justify continued efforts to reduce their incidence. One is the development of gastrojejunal ulceration, which is reported to occur in approximately 2 to 5 per cent of cases in most large series.[1, 2] The other is the appearance of certain postoperative sequelae such as intolerance for certain foods, the dumping syndrome, the need for eating frequent small meals, difficulty in maintaining weight, inability to perform hard labor or to tolerate stress and strain and restrictions on the use of alcohol and tobacco. The severity of these side effects varies considerably from patient to patient.

The addition of resection of the vagus nerves to the surgical armamentarium has made it desirable to determine whether any other procedure is of greater value than subtotal gastrectomy for the patient with duodenal ulcer who requires surgery. For this reason we have been engaged in a study of this problem during the past few years. The study has consisted of two parts, the first being a detailed investigation of the effect of operation on the acidity and peptic activity of the gastric contents of small groups of patients undergoing various procedures. The cases have been studied in the preoperative and immediate postoperative state and at intervals thereafter. We have been particularly interested in postoperative gastric acidity, for we are not aware

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of any case in which gastrojejunal ulceration has developed in the absence of free hydrochloric acid under the conditions of study employed. The second part of the program is a careful evaluation of the clinical results.

To date, both the physiologic and the clinical results in a small series of cases subjected to hemigastrectomy and vagotomy have been more uniformly satisfactory than those of any other procedure we have employed, including subtotal gastrectomy. Although the results of subtotal gastrectomy in many cases leave little or nothing to be desired the greater consistency of good results, both physiologic and clinical, of hemigastrectomy in addition to vagotomy has led us to believe that this combined maneuver is the one most likely to prove superior to subtotal gastrectomy in the management of patients with duodenal ulcer who require surgery. The following discussion briefly summarizes the results of hemigastrectomy and vagotomy to date and compares them with those of the other procedures employed.

TABLE 1. *Acidity of Gastric Contents in Normal Persons and in Patients with Duodenal Ulcers and Gastrojejunal Ulcers after Various Operations.*

SUBJECTS OF TEST	NO. OF CASES	ACIDITY UNDER BASAL CONDITIONS		ACIDITY AFTER BROTH STIMULATION		ACIDITY AFTER INJECTION OF INSULIN	
		milliequiv./hr.	*pH*	*milliequiv./hr.*	*pH*	*milliequiv./hr.*	*pH*
Normal controls	16	0.9	3.7	3.8	2.6	4.2	1.5
Patients with duodenal ulcer	41	5.0	1.8	7.1	1.7	8.3	1.6
Patients with gastrojejunal ulcer	17	2.9	2.3	5.6	2.0	5.0	1.9

METHOD OF STUDY

Our routine for the chemical evaluation of the gastric contents of patients with ulcer has previously been described.[3, 4] Gastric contents are continuously aspirated for an hour under "basal" or fasting conditions and for an hour after the introduction and removal of peptone beef broth, a powerful physiologic stimulus for the chemical phase of gastric secretion. We prefer this potent food stimulus to histamine because we believe that it gives a more accurate indication of the response of the parietal cells to food intake.[4] Insulin, administered intravenously, is used to activate the neurogenic phase of gastric secretion. The gastric contents are collected for two hours in two one-hour aliquots. The pH of each specimen is recorded with a Beckman pH meter, and units of free acid are determined by electrometric titration to a pH of 3.5. The volume is measured and free acidity is calculated in terms of total milliequivalents produced per hour. (Volume x units of free acid)

$$\frac{\text{Volume} \times \text{units of free acid}}{1000}$$

PHYSIOLOGIC RESULTS

As previously pointed out,[3, 5] a striking difference between normal persons and patients with duodenal ulcer is the excessive quantity of acid produced by the latter not only on stimulation but especially under fasting conditions of study. A similar though less marked contrast is noted if the acid values for normal controls are compared with those of patients with gastrojejunal ulcer. Table 1 gives the acidity of the gastric contents in terms of pH and total milliequivalents per hour in 16 normal controls, 41 patients with duodenal ulcers and 17 patients with gastrojejunal ulcers after various operations. The average figures for acidity in the patients with gastrojejunal ulcer are only slightly lower than those in the cases of duodenal ulcer without operations. The operations performed had for one reason or another failed to modify the acid-peptic factor sufficiently to protect the patients against recurrent ulceration. If the figures for the 17 gastrojejunal ulcers are individually examined it is found that in every case the pH of the gastric contents was below 3.5 under one or more conditions of study. That some patients with jejunal ulcer have extremely low acid values, however, is demonstrated by Table 2, which compares the findings in normal controls with those of the 2 patients with the lowest acid values among the cases of gastrojejunal ulcer. In each of these patients the ulcers had developed within two years of radical subtotal gastrectomies. Although decreased resistance of the mucosa to digestion may have played a part in these cases it might well be argued that if the acid-peptic factor had been more effectively modified by the operations performed recurrent ulceration would not have occurred. It is obvious from our studies that simply to reduce gastric acidity to within the normal range will not give uniform protection against recurrent ulceration. The findings suggest that achlorhydria as indicated by a pH of the gastric contents of 3.5 or more under all the conditions of

TABLE 2. *Acidity of Gastric Contents in 2 Patients with the Lowest Acidity as Compared with Normal Controls.*

PATIENT	ACIDITY UNDER BASAL CONDITIONS	ACIDITY AFTER BROTH STIMULATION	ACIDITY AFTER INJECTION OF INSULIN
	milliequiv./hr.	*milliequiv./hr.*	*milliequiv./hr.*
J. C.	0.0	0.2	1.3
D. S.	0.0	0.7	1.2
Normal controls	0.9	3.8	4.2

study outlined is necessary to ensure protection against the development of gastrojejunal ulceration.

We have noted a considerably higher incidence of achlorhydria after hemigastrectomy combined with resection of the vagus nerves than after any other procedure studied. In Table 3 the physiologic results of this combined maneuver are compared with those of subtotal gastrectomy alone and in combination with vagotomy, vagotomy and resection of the distal third of the stomach, vagotomy combined with gastroenterostomy and finally with the results in the patients with gastrojejunal ulcer. Ninety-three per cent of 40 patients had a pH of 3.5 or more under all conditions of study after hemigastrectomy in addition to vagotomy. Included in this group were many patients with extraordinarily high preoperative acidity levels — considerably higher, in fact, than those in any other category. This did not appear in any way to modify a satisfactory outcome. In each of the 3 patients with free hydrochloric acid in the postoperative period incomplete section of the vagus nerve was clusively demonstrated by the Hollander[6] insulin test. It seems probable that if the nerve sections had been complete all the patients would have been achlorhydric.

After posterior gastroenterostomy in addition to vagotomy only 3 of 12 patients were achlorhydric. If gastric acidity alone is considered, this incidence of achlorhydria does not appear to us sufficiently high to justify posterior gastroenterostomy combined with vagotomy as a routine procedure. Although other factors incident to vagotomy, such as reduction in pepsin output, modification of gastric and intestinal tone and possible, favorable effects on circulation, may aid in the prevention of stomal ulceration it is to be noted that reports of this complication after gastroenterostomy and vagotomy are beginning to appear.[7, 8]

After a brief experience with removal of approximately a third of the stomach in combination with vagotomy we found that the physiologic results, although an improvement over posterior gastroenterostomy combined with vagotomy, fell short of satisfaction in 50 per cent of the cases. It appears that removal of only the distal third of the stomach cannot be counted upon to abolish the hormonal mechanism for the secretion of acid.

Among 20 patients subjected to subtotal gastrectomy (two thirds to four fifths) 65 per cent were found to be achlorhydric in the postoperative period. It is probable that had the more radical type of subtotal gastrectomy (three fourths to four fifths) been performed in all cases the incidence would have been higher.[9] It is of interest, however, that 4 of the gastrojejunal ulcers referred to in Table 1 followed operations of this magnitude.

The predictable uniformity of satisfactory physiologic results that follow hemigastrectomy in addition to vagotomy is not seen after subtotal gastrectomy. We hoped, for example, that with attention to preoperative responses to various stimuli, patients could be selected for certain procedures. Two patients with relatively low preoperative

TABLE 3. *Effect of Various Operations for Duodenal Ulcer on Gastric Acidity As Judged by the Incidence of Achlorhydria under Fasting Conditions of Study and after Stimulation by Beef Broth and Insulin.*

OPERATION	NO. OF CASES	FREE HYDROCHLORIC ACID PRESENT*		FREE HYDROCHLORIC ACID ABSENT†	
		NO. OF CASES	PERCENTAGE	NO. OF CASES	PERCENTAGE
Gastrojejunal ulcers after various operations	17	17	100	0	—
Posterior gastroenterostomy in addition to vagotomy	12	9	75	3	25
Gastrectomy (distal third) combined with vagotomy	6	3	50	3	50
Gastrectomy (two thirds to four fifths)‡	21	7	33	14	67
Gastrectomy (two thirds to four fifths) combined with vagotomy	8	2	25	6	75
Hemigastrectomy combined with vagotomy	40	3	7	37	93

*pH below 3.5.
†pH of 3.5 and over.
‡Cases with jejunal ulcers not included in these figures.

TABLE 4. *Acidity of Gastric Contents before and Immediately after Operation in 2 Patients Selected for Two-Thirds Gastrectomy on the Basis of Relatively Low Preoperative Acidity.*

PATIENT	ACIDITY UNDER BASAL CONDITIONS				ACIDITY AFTER BROTH STIMULATION				ACIDITY AFTER INJECTION OF INSULIN			
	BEFORE OPERATION		AFTER OPERATION		BEFORE OPERATION		AFTER OPERATION		BEFORE OPERATION		AFTER OPERATION	
	milliequiv./hr.	*pH*	*milliequiv./hr.*	*pH*	*milliequiv./hr.*	*pH*	*milliequiv./hr.*	*pH*	*milliequiv./hr.*	*pH*	*milliequiv./hr.*	*pH*
A. N.	0.96	1.6	1.8	1.9	1.0	2.0	1.0	2.1	0.2	3.5	1.6	1.0
M. deM.	0.8	2.0	1.2	2.0	2.6	1.8	0.6	2.3	5.9	1.2	0.9	2.1

acidities and with minimal neurogenic responses were selected for two-thirds gastrectomies. Table 4 shows the disappointing physiologic results. The operations have had little effect upon the acidity of the gastric contents. Despite the low preoperative acidity these are the poorest results among the patients subjected to subtotal gastrectomy.

Eight patients are listed in Table 3 under the heading gastrectomy (two thirds to four fifths) combined with vagotomy. Gastrojejunal ulcers had developed in 6 after subtotal gastrectomies. In these cases vagotomies were performed after the appearance of the recurrent ulcer. The physiologic results of this more extensive combined maneuver should theoretically be at least as good as those of hemigastrectomy combined with vagotomy. In this small series of 8 cases the nerve section was incomplete in 2 cases in which vagotomy was performed after the appearance of a gastrojejunal ulcer. In each, the pH of the gastric contents proved to be below 3.5 in the postoperative period. In 1 of these the ulcer healed promptly, but in the other a secondary vagotomy was recently performed. The fact that 2 patients in a small series proved to have incomplete vagotomies probably explains why the physiologic results listed in Table 3 for subtotal gastrectomy combined with vagotomy are not as satisfactory from a percentage standpoint as those in a much larger series of patients undergoing hemigastrectomy in addition to vagotomy. As the series enlarges, this discrepancy should correct itself.

If recurrent ulceration follows subtotal gastrectomy alone and if one can be certain that the antrum has been removed, vagotomy is probably preferable to resection of the ulcer and extension of the gastrectomy.

It seems clear that in the employment of any procedure whose success depends in part upon vagotomy the hazard of incomplete nerve section is one to be seriously considered. Among the 66 procedures involving vagotomy listed in Table 3, the standard insulin test gave evidence of intact nerve fibers in 13 cases. By definition[6] each of these patients showed free hydrochloric acid during postoperative studies. It is possible that achlorhydria masked additional examples of incomplete nerve section. An increase or decrease in pH in the achlorhydric range represents an infinitesimal change in hydrogen ion concentration, and factors such as reflux of duodenal contents, alterations in volume of gastric contents and variations in the amount of mucin present could easily modify a minute increase in hydrogen ion concentration resulting from insulin stimulation. It appears that the important feature is the achievement of achlorhydria whether or not the nerve section is anatomically complete.

If incomplete nerve section leads to the presence of free hydrochloric acid long-term follow-up studies may show this to be a serious matter. If the "physiologic failures" after these various procedures are compared it is again seen that the results of hemigastrectomy combined with vagotomy are relatively more favorable than those of any other primary procedure. Table 5 compares the total milliequivalents of free hydrochloric acid in the gastric contents of the patients in whom the pH fell below 3.5 after operation. The acid values for the cases in which posterior gastroenterostomy combined with vagotomy failed to achieve achlorhydria are surprisingly high when compared to those after hemigastrectomy in addition to vagotomy. We believe that this constitutes an additional argument in favor of the latter combination since a significant incidence of incomplete vagus-nerve section is apparently inevitable in any of the combined maneuvers.

Another hazard is the possibility of regeneration of the vagus nerves. Dragstedt et al.[10] have apparently not found this to be a problem. In 22 out of 66 procedures involving vagotomy listed in Table 3 studies have been carried out immediately after operation and also one to five years later. Eighteen of the 22 patients were achlorhydric after insulin stimulation in the initial postoperative period. In no case did later tests reveal the presence of free hydrochloric acid. This suggests that there has not as yet been any significant degree of nerve regeneration.

TABLE 5. *Acidity of Gastric Contents in Patients with pH Below 3.5 after Various Operations.*

OPERATION	NO. OF CASES	ACIDITY UNDER BASAL CONDITIONS	ACIDITY AFTER BROTH STIMULATION	ACIDITY AFTER INJECTION OF INSULIN
		milliequiv. /hr.	*milliequiv. /hr.*	*milliequiv. /hr.*
Posterior gastroenterostomy combined with vagotomy	9	2.3	6.8	2.5
Gastrectomy (one third) combined with vagotomy	3	1.0	0.5	0.6
Gastrectomy (two thirds to four fifths)	7	0.9	0.8	1.2
Gastrectomy (two thirds to four fifths) combined with vagotomy	2	1.2	0.9	2.7
Hemigastrectomy combined with vagotomy	3	0.2	0.2	0.4

Clinical Results

The term clinical result refers to the presence or absence of postoperative side effects mentioned above. To evaluate the results of any operation for duodenal ulcer in the proper manner it is necessary to obtain a detailed personal interview with each patient. For a fair appraisal of different operations it is desirable that the same physician conduct all the interviews.

It has been our impression, as well as that of others, that the smaller the gastric remnant, the greater the incidence of postoperative symptoms. This is difficult to prove, for the majority of patients who have suffered with duodenal ulcers severe enough to warrant surgery are so grateful that on superficial questioning their enthusiasm may cover up numerous difficulties that are so mild as to be hardly worth mentioning by comparison with the original problem. We consequently examine each patient with careful attention to the following factors: weight; ulcer pain; appetite; specific food intolerance; amount of food ingested at one time; number of meals required per day; fullness, distress, regurgitation, nausea or vomiting after eating; dumping symptoms; restrictions in the use of tobacco, alcohol or coffee; gas — excessive belching or flatus; strength — ability to carry out a full day's work, physical or mental, without tiring; bowel regularity; necessity for diet or medication; hemoglobin; and degree of satisfaction with the operation.

The clinical results in patients followed for one to five years after various operations are listed in Table 6. Earlier postoperative results are not included in this classification. If a result is classified as excellent it means that we were unable to elicit a history of any abnormality whatsoever and that the patient is leading an entirely normal life from a gastrointestinal standpoint. In the presence of one or two of the less serious sequelae, such as a specific food intolerance or occasional episodes of slight postprandial distress, and if the patient was completely satisfied, the result is classified as good. If in spite of several minor sequelae or one of the more disabling side effects the patient was still satisfied, the result is classified as fair. If the patient was dissatisfied or was seriously disabled in any way, the result is classified as poor. This classification is stringent, but if it applies to all cases the comparison should be fair.

The clinical results of subtotal gastrectomy were in general very satisfactory. The major difference between the results of this procedure and those of hemiga trectomy combined with vagotomy is that after the latter something approaching perfection was attained in a much higher percentage of cases.

Table 6. *Clinical Results in Terms of Presence or Absence of Undesirable Sequelae One to Five Years after Various Operations for Duodenal Ulcer.*

Operation	No. of Cases	Excellent Results	Good Results	Fair Results	Poor Results
		No. of cases	No. of cases	No. of cases	No. of cases
Posterior gastroenterostomy combined with vagotomy	8	4	4	0	0
Gastrectomy (two thirds to four fifths)	14	2	7	4	1*
Gastrectomy (two thirds to four fifths) combined with vagotomy	6	1	2	3	0
Hemigastrectomy combined with vagotomy	23	12	7	3	1*

*Poor results in each case were due to intermittent attacks of partial small-bowel obstruction at a point distal to the gastrojejunostomy.

It may be of significance that among a total of 19 patients whose results could be termed excellent only 3 had a gastric remnant consisting of less than half the stomach. Although results in a small series such as this are not conclusive, if these cases are classified according to the size of the gastric remnant the findings (Table 7) tend to support the suggestion that the extent of gastrectomy has a distinct bearing on the incidence of side effects after operation.

Table 7. *Relation between Size of Gastric Remnant and Clinical Result in Terms of Presence or Absence of Undesirable Sequelae after Various Operations for Duodenal Ulcer.*

Size of Gastric Remnant	No. of Cases	Excellent Result	Good Result	Fair Result	Poor Result
		No. of cases	No. of cases	No. of cases	No. of cases
Less than 50 per cent	20	3	9	7	1
50 per cent or more	31	16	11	3	1

Summary

In recent years we have combined hemigastrectomy with resection of the vagus nerves in a series of 40 patients with duodenal ulcer. Detailed studies of the acidity of the gastric contents have been carried out before operation and at intervals in the postoperative period.

The findings are compared with those obtained after subtotal gastrectomy alone and combined with vagotomy, vagotomy combined with resec-

tion of the distal third of the stomach and vagotomy combined with posterior gastroenterostomy and also with the results in 17 patients with gastrojejunal ulceration after various operations.

Achlorhydria under fasting conditions of study and on stimulation by beef broth and insulin occurred more frequently after hemigastrectomy combined with resection of the vagus nerves than after any other procedure employed.

Achlorhydria should theoretically occur at least as frequently after subtotal gastrectomy combined with vagotomy as after hemigastrectomy combined with vagotomy. That this was not so in the series discussed is explained by the fact that 2 of 8 patients subjected to this more radical procedure had incomplete nerve sections whereas only 3 of 40 patients who had hemigastrectomy combined with vagotomy proved to have incomplete nerve sections.

The results of this study suggest that hemigastrectomy combined with vagotomy will afford the patient with duodenal ulcer greater protection against recurrent ulceration than vagotomy combined with gastroenterostomy or the removal of less than half the stomach or subtotal gastrectomy alone.

Hemigastrectomy combined with vagotomy has been followed by a lower incidence of unpleasant postoperative side effects than subtotal gastrectomy alone or combined with resection of the vagus nerves.

When evaluated on the basis of both the physiologic effects and the clinical results, hemigastrectomy combined with vagotomy has so far given the best results in our experience.

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MEDICAL PROGRESS

NEW TECHNICS AND MATERIALS IN UPPER-EXTREMITY PROSTHETICS*

Augustus Thorndike, M.D.†

BOSTON

THE Government's research program in the fields of prosthetic appliances and sensory aids authorized by Public Law 729 of the 80th Congress (1948) includes the authority to appropriate up to $1,000,000 a year. This program is a joint undertaking of the Army, Air Force, Navy and Veterans Administration, under the supervision of the appropriate committees of the National Research Council of the National Academy of Sciences. Public Law 729 designates the Veterans Administration as the agency responsible for administering the program. When it is considered that $5,500,000 has been expended in this program during the past seven years, it is essential that the taxpayers be advised. I am here presenting the developments and results of the phase of this research program, which is under the supervision of the Advisory Committee on Artificial Limbs of the National Research Council, more specifically that which concerns amputations of the upper extremity and the fitting and harnessing of these amputations to modern prostheses.

The fundamental research and basic procedures that have been accomplished in this upper-extremity field are the results of a contract with the college of Engineering of the University of California at Los Angeles. After a long period of research and motion studies of the activities involved in the tasks of daily living by patients with unilateral and bilateral arm amputations, certain basic criteria and specifications were established, producing the modern arm prosthesis. Through the research efforts of Northrop Aircraft, Incorporated, and the A. J. Hosmer Corporation, plastic laminate sockets and arm shells, Bowden cables and plastic webbing harnesses are the basic materials now utilized. No longer are molded leather or long steel hinges necessary, plastic laminate sockets and flexible elbow hinges for the below-elbow stump representing the routine items of prescription. In terminal devices new hooks of aluminum alloy with newly designed rubber-faced prehension surfaces

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and a new functional hand have all resulted in a lightweight, easily operated substitute for the lost arm and hand. One must appreciate the fact that the best terminal device can only serve as a poor substitute for the normal, functioning hand and its digits.

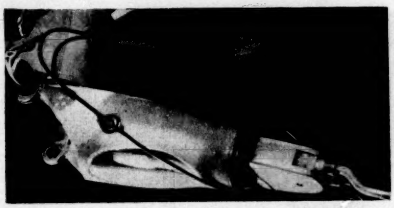


FIGURE 1. *Below-Elbow Prosthesis, with Rotating Socket Permitting Pronation and Supination of Hand or Hook (Note That the Hinge Provides Only Elbow Flexion and Extension).*

Mazet and Taylor[1] have rendered a valuable report on some of these developments. However, that surgeons may be better able to prescribe the modern artificial arm, further dissemination of this information is necessary. The surgeon's responsibility extends to the final acceptance, training and utilization of the prosthesis by his patient.

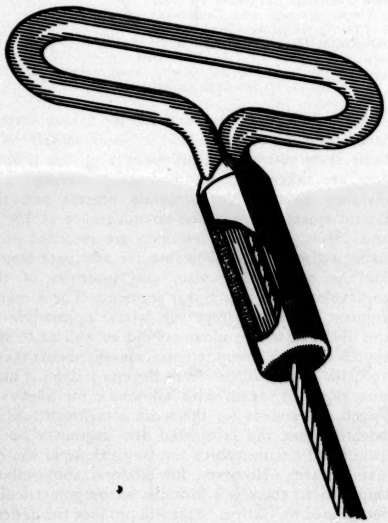


FIGURE 2. *Terminal Attaching Steel Bowden Cable to Webbing Harness.*

The modern prosthesis consists of the arm segments and its assembled parts, its suspension or attachment and its harness and cable designed for operation of the variously required arm segments, as well as the selected terminal device.

Fabrication and Fitting of the Artificial Arm

The modern artificial arm is constructed basically of dyed stockinet, impregnated with thermosetting plastic resins cured by oven heating from 180°F. to 250°F. for a total of an hour. Among the most commonly used resins are styrene polyesters. One of several satisfactory groups is known by the trade name of Laminac* series 4116 rigid and Laminac series 4134 flexible, freshly mixed in correct proportions with a catalyst known as Lupercot ATC.[2] The stockinet is impregnated by stretching over a positive plaster break-out mold and enveloping in a polyvinyl alcohol sleeve closed at the bottom, the mixed liquid plastic then being poured into the open end of the sleeve and squeezed digitally until it is forced through the entire length and substance of the stockinet. When the stockinet is completely saturated, some excess resin should be maintained at the open end of the sleeve to keep air out of contact with the impregnated laminate. The entire envelope and its enclosure are then placed in the oven for curing. Space does not permit a more detailed description of fabrication, assembly and socket patterning; however, information is available for those interested.[2] Compared to that of the below-elbow artificial arms formerly constructed of long-armed steel hinges and leather, the weight is considerably less, and the problems of durability, sanitation and maintenance are simplified.

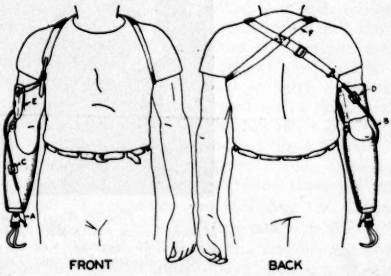


FIGURE 3. *Acceptable below-Elbow Harness with Open Biceps Cuff — a Continuous Helical Housing for the Cable.*

*Available from American Cyanamid Company, Pearl River, New York.

†Available from Novadel Agene Corporation, Buffalo, New York.

In the below-elbow arm, the fitting and measurements are relatively simple. Provided no synostosis of radius and ulna is present in the long stump, the socket is fabricated over a well modeled break-out cast of proper length and circumference and fitted with a wrist attachment so as to receive the insertion of the selected terminal device. Sometimes, however, with a stump of medium length and less than 90° of pronation and supination, it may become necessary to provide an inner socket with a pronation-supination stump-driven step-up arm unit with lock (Fig. 1). With a 2.3 to 1 step-up ratio, a useful pronator and supinator of the terminal device is readily obtained.

In fabrication of the upper-arm and lower-arm segments for a patient with a unilateral above-elbow amputation, the methods for taking certain measurements of circumference and length have been systematized. Measurements of the normal arm are taken and recorded on a tracing. The distance between the acromion process and the lateral epicondyle and the circumference at 15, 20 and 25 cm. from the acromion are recorded on a paper pattern, with allowance for adequate length for the elbow mechanism and insertion of the turntable in the upper-arm segment. The forearm segment measured from the lateral epicondyle of the humerus to the ulnar styloid as well as to the thumb tip, with circumferential measurements taken at 5, 10, 15 and 20 cm. from the epicondyle, is likewise recorded, again with allowance for adequate length adjustment for the wrist attachment. It is essential that the fabricated arm segments be of length and circumference similar to those of the remaining arm. However, for bilateral above-elbow amputations there is a formula, anthropometrically determined by Carlyle,[4] that will produce the desired lengths in ratio to the remainder of the body. It is essential that both segments of the above-elbow arm be made symmetrical in the bilateral case. The insertion of a turntable above the mechanical elbow is required for proper rotation of the lower-arm segment about the longitudinal humeral axis for certain functions.

FIGURE 4. *Typical Wrist Disarticulation Prosthesis Suspended by Close Molding about the Styloid Processes, Simple Harness and Continuous Helical Cable Housing (Note the Length of the Socket on the Ulnar Surface to Resist Bending Load and Yet the Low Radial Margin to Permit Wrist Rotation).*

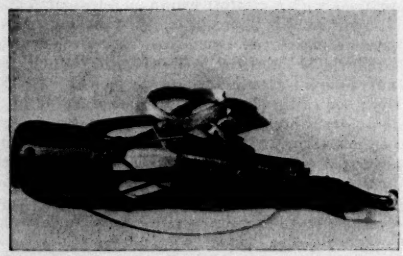


FIGURE 5. *Typical Mid-Forearm Prosthesis, Permitting Pronation and Supination by Flexible Cable Serving as Elbow Hinges.*

The functioning and efficiency of operation of an arm and its terminal device are dependent upon its suspension, its efficient transmission of motive power and its hook-up of harness with cable.

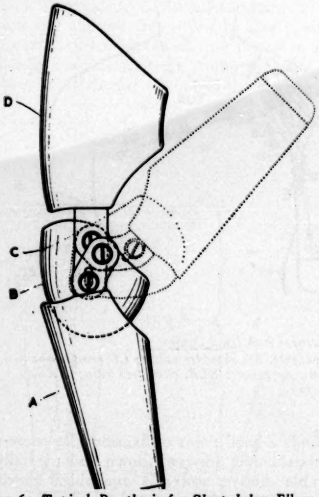


FIGURE 6. *Typical Prosthesis for Short, below-Elbow Stump, with Insert Socket.*
The polycentric hinge permits full flexion of the prosthetic forearm, with limited flexion of the stump.

Rather than complex methods of harness to leather thong or cord, in use at present is the aeronautical engineer's Bowden cable with housing attached to a vinyon (plastic) webbing harness with buckle through a cable terminal[5] (Fig. 2). Of course, the difference in the suspension and harness of the below-elbow amputation as compared to the above-elbow type must be appreciated. Figure 3 demonstrates an acceptable below-elbow harness (Fig. 3).

Furthermore, there is a marked difference between the type of suspension for a long below-elbow and that for the short below-elbow stump. The wrist disarticulation, including ulnar and radial styloid processes, can be fitted so closely that the bony contours and the socket itself maintain the necessary suspension for light-work usage. The middle-third below-elbow amputation requires long, flexible hinges of leather or plastic-covered steel cables attached to a leather cuff placed above the elbow about the lower third of the triceps area. For the extremely short below-elbow stump, a special insert socket, adequately notched for the biceps tendon, can be fabricated with a polycentric hinge that gives an effective, full range of flexion and extension of the prosthesis (Fig. 4, 5 and 6).

For the medium-length (over 15 cm. from the acromion) above-elbow amputation there are two methods of suspension, one utilizing the Carnes[6] type and the other the leather-saddle type (Fig. 7 and 8). On the other hand, the very short above-elbow and the shoulder disarticulation require a molded shoulder cap, this in itself serving as the main point of suspension.

The below-elbow stump requires much less harness for suspension and power transmission but still requires a point of fixation or anchor. The most important factor in the principle of harnessing is to find a counterpoint to which the cable

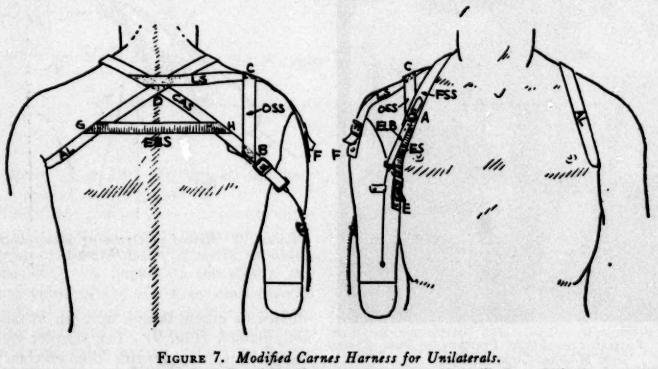


FIGURE 7. *Modified Carnes Harness for Unilaterals.*
Location points: A, B, C, D, E, F, G and H. Harness components: AL, axilla loop; FSS, front support strap; OSS, over-shoulder strap; LS, lateral suspensor; ES, elastic suspensor; ELB, elbow lock billet; CAS, control attachment strap; and EBS, elastic back strap.

is anchored. Obviously, the ideal point in the human torso is the opposite shoulder girdle — this of-8 principle of bandaging in a loop, with vinyon tape about the opposite shoulder girdle,

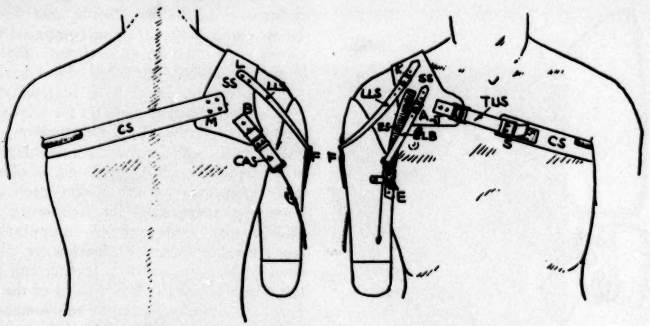


FIGURE 8. *Leather Shoulder-Saddle Harness with Dual Control.*
Location points: A, B, F, J, K, L, M and S. Harness components: SS, shoulder saddle; CS, chest strap; TUS, take-up strap; LLS, lateral loop suspensor; ES, elastic suspensor; ELB, elbow lock billet; CAS, control attachment strap.

also applies to patients with bilateral amputations, who use each shoulder independently. In certain

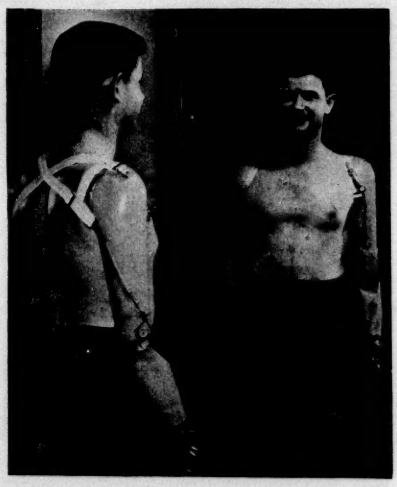


FIGURE 9. *Typical above-Elbow Prosthesis — Dual Control from Modified Carnes Harness.*
Stump flexion against the anchor on opposite shoulder provides elbow flexion or operation of hook, or both. A second control is shown in Figure 10.

types of harness this counterpoint may serve as a source of motive power. Utilizing the figure-

one finds a good point of fixation. By mere motion of this shoulder forward, down and medially, considerable motive power is available. Flexing the amputated upper-arm stump while the opposite shoulder is fixed is another technic of providing necessary motive power to operate a terminal

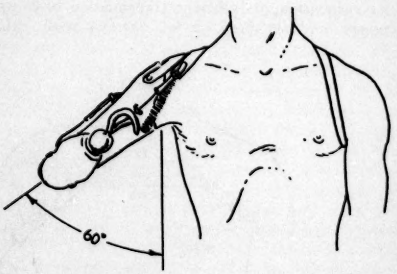


FIGURE 10. *Method of Operating Elbow Lock by Abduction of Stump.*

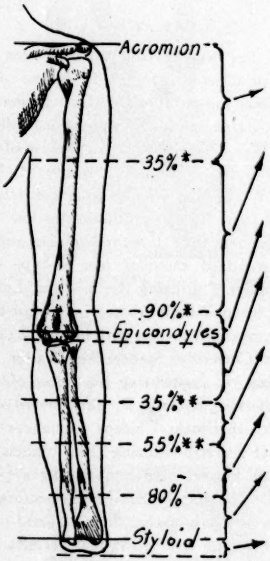
device or elbow flexion or both in an above-elbow amputation (Fig. 9). The simpler the harness arrangement, the greater the efficiency of transmission of available motive power.

An essential feature needed by the patient with an above-elbow amputation is controlled elbow stability. Thus, he can carry objects with the elbow flexed or, conversely, can hold paper on a desk or meat on a plate. One device, requiring con-

tinuous muscular activity, is the Navy–Fitch arm.[7] Generally, to permit stump relaxation, a mechanical elbow lock is provided. Early locks required manual operation and allowed only a few locking positions. The newest lock has eleven locking positions and is operated by abduction of the stump to pull a cord, the action being similar to that of the electric-light-operating the terminal device, but after the elbow is locked, energy is transmitted through the cable solely to the terminal device.

Prescription of the Artificial Arm

In the proper prescription of an arm prosthesis, the surgeon should describe the required substitute



Type of Amputation	Standard Equipment
Shoulder disarticulation	Integral shoulder and arm socket, elbow unit, forearm section, dual harness control operated by shoulder shrug
Above elbow	Arm socket, elbow unit, forearm section, dual (modified Carnes) or triple control harness
Elbow disarticulation	No standard equipment available
Very short below elbow	Split socket, polycentric hinges, closed arm cuff, single control with figure-of-8 harness (dual control used occasionally)
Short below elbow	Single socket, steel hinges, arm cuff, single control with figure-of-8 harness
Medium below elbow	Rotation-type forearm with double socket and rotation step-up, "soft hinge" and cuff, single control with figure-of-8 harness
Long below elbow	Single socket, flexible hinge, triceps pad, single control with figure-of-8 harness
Wrist disarticulation	Single socket, flexible hinge, triceps pad, single control with figure-of-8 harness

Figure 11. *Standard Types of Amputation and Applicable Equipment.*

socket pull chain (Fig. 10). To unlock the lock one abducts a second time.

The so-called triple-control harness permits three independent functions — usually operation of the terminal device by shrug of the opposite shoulder, flexion of the elbow by flexion of the stump and locking or unlocking of the elbow by abduction of the stump. Dual control (some independence of function being sacrificed to attain a simpler harness) uses a single cable tensed by stump flexion against an anchorage on the stationary opposite shoulder for both terminal-device operation and elbow flexion, in addition to a second stump abduction control for elbow locking. Terminal-device operation and elbow flexion are thus independent in time — that is, when the elbow is unlocked, tensing the cable flexes the elbow in preference to

in terms of the tissue loss — for example, 40 per cent loss above the elbow (Fig. 11). He should realize that even today, there is no satisfactory prosthesis for the elbow disarticulation. He should become familiar with the new armamentarium needed for the assembly of the various types of artificial arms by which, with adequate training, the patient will regain self-reliance. Proper prescription requires the co-ordinated efforts of what is now known as the prosthetic team, consisting of those concerned with the fabrication of the apparatus and the fitting, harnessing and training of the patient in the use of his arm and hand substitute. The surgeon, who is designated as the captain, the occupational or physical therapist, or both, the limb fitter and the patient all contribute in the discussions of talents, occupational goals and other

Case No. ..... Name .....
Type of amputation: ..... Prosthesis type: .....

BELOW-ELBOW PROSTHESIS

1. Arm cuff: Open ..... Closed ..... Semiopen .....
   Other .....
2. Elbow articulation: Leather ..... Cable housing .....
   Side straps ..... Other .....
3. Socket: Double ..... Single ..... Strengtheners .....
4. Shell material (outer socket): .....
   Strengtheners .....
5. Rotation unit: .....
6. Special modifications .....

ABOVE-ELBOW PROSTHESIS (including shoulder disarticulation)

7. Elbow unit: .....
8. Socket: Double ..... Single ..... Shoulder cap .....
   Strengtheners .....
9. Shell material (if double socket): .....
   Strengtheners .....
10. Forearm material ..... Strengtheners .....
11. Special modifications .....

CONTROL SYSTEM

Dual ..... Triple ..... Other .....

HARNESS

12. Type .....
13. Material .....

DIAGRAM OF HARNESS AND CONTROL PATH

TERMINAL DEVICE AND WRIST DEVICES

14. Hook .....
15. Hand .....
16. Disconnect unit .....
17. Wrist flexion unit .....
18. Wrist length adapters .....

CONTROL SYSTEM

19. Bowden cable: Proximal attachment .....
    Distal attachment: .....
20. Cable length adjusters .....
21. Additional control .....

VARIANCES FROM TYPE: .....

Signed ..... M.D.

FIGURE 12. *Typical Prescription Form for Arm Prosthesis.*

factors leading to the final writing of an effectively comprehensive prescription (Fig. 12). The same team is convened again at the period of preliminary fitting, after the training period and at the time of final acceptance of the limb and discharge of the patient. Even after discharge, the patient should be followed periodically. The surgeon cannot assume that his responsibility is terminated when the wound is healed.

CINEPLASTY

Cineplasty has been revived and has been used successfully in selected cases in the biceps muscle for below-elbow amputations. Most patients in Sauerbruch's[8] large series of amputations followed after World War I have abandoned the use of their small forearm-muscle tunnels. Kessler's[9] Navy Veterans of World War II who have come to the attention of the Veterans Administration have largely abandoned their forearm tunnels and are now using standard shoulder harness-type prostheses. Alldredge,[10] utilizing the modified Lebsche technic for biceps-muscle motor in below-elbow amputations, reported success with his first 2 experimental cases. Currently, Spittler,[11] at Walter Reed Army Hospital, is augmenting his series of cases with biceps-muscle motors. To date, most of the patients with experimental biceps appliances since World War II are still utilizing their tunnels successfully — the longest case representing a period of six years. The importance of transecting the biceps tendon and imbricating the distal end of the muscle seems to be a refinement that permits more tunnel excursion after healing. The physiologists utilizing the Blix curve[12] in the training of these two muscle motors have demonstrated that, with these muscles, excellent force and control are available at any point within an excursion of at least 4 cm. for direct operation of the terminal device. Inman and Taylor[13] have described the surgical, physiologic and engineering principles concerned with a well made muscle tunnel. The advantage of this procedure for the below-elbow amputation is the elimination of all need for shoulder harness. To describe in detail these new developments would require more time and space than is available.

Cineplasty utilizing the pectoralis-major muscle is useful for the short above-elbow or certain shoulder disarticulation amputations and has been used effectively since World War II in a few cases. However, owing to the angles required in cable attach-

ment, the possibility of rotation of the socket on the stump exists. Spittler has described this specialized operative procedure.[11]

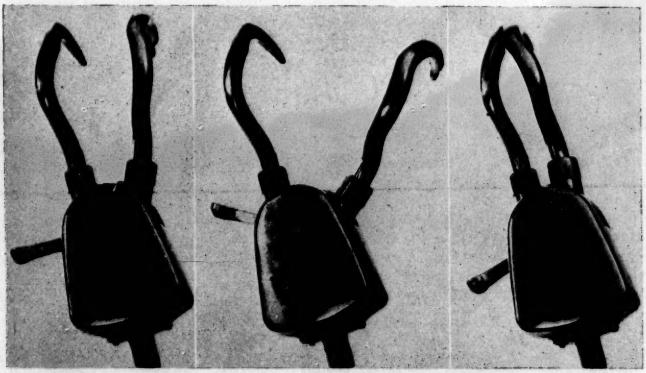


FIGURE 13. *APRL Hook, Demonstrating 4-Cm. and 8-Cm. Openings and Locking in the Closed Position (Note the Rubber Lining of Prehension Surfaces of Lyre-Shaped Fingers).*

TERMINAL DEVICES

In the design and development of new terminal devices for the modern artificial arm, the Government's research program has focused its attention on a solution of the problem of controlled force in prehension. The most commonly prescribed commercially available split hooks have provided an uncertain force from steel springs or heavy rubber bands to close the hook, while a force transmitted through the cable, or cord, voluntarily opens the jaws. What seemed essential was to provide a voluntarily controlled closing force to accomplish measured prehension so that either a paper cup or a 10-pound weight might be grasped or handled. The Army Prosthetics Research Laboratory (APRL)

FIGURE 14. *APRL Hand with Cosmetic Glove (Note the Two Positions of the Preset Thumb).*

has developed this item, including a clutching and locking device in the mechanism, which allows the operated switch, which either throws out the locking mechanism or controls the hook finger opening at

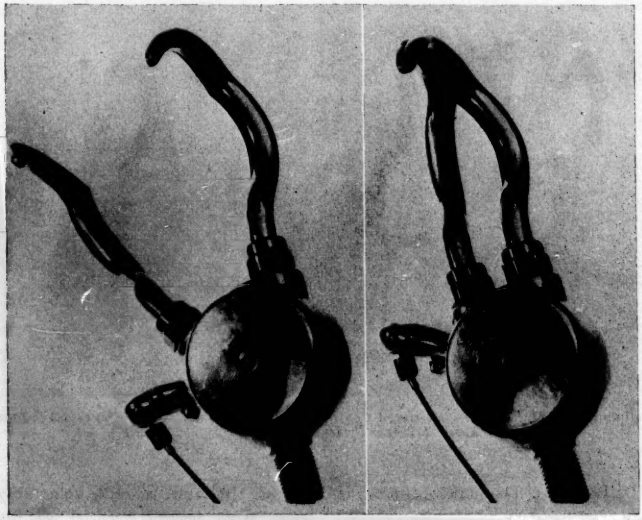


FIGURE 15. *Northrop Two-Load Hook, with Manual-Control Switch for Control of Spring Force Equivalent to 3½ or 7 Pounds.*

patient to lock on the object and then release all tension on the cable. Reapplication of a slightly

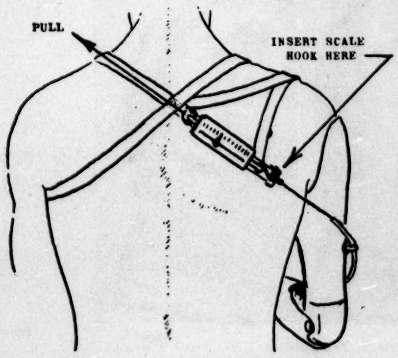


FIGURE 16. *Flexion of the Elbow with the Examiner Exerting 10 Pounds' Force on the Fish Scale, the Terminal Device Being Taped and the Elbow Unlocked in 90° Flexion.*

increased tension on the cable will release the lock. The APRL hook provides even further a manually 4 cm. or at 8 cm. (Fig. 13). The same laboratory has devised an artificial hand utilizing the same voluntary closing principle. The hand is covered by its polyvinyl chloride-plastic cosmetic glove (Fig. 14). Therefore, the principle of voluntarily controlled prehension force has been made available in an interchangeable hook and artificial hand.

Moreover, this research program has not overlooked the need for improved design and development in the voluntarily opening hook. The Northrop Aircraft Laboratory, under contract with the Veterans Administration, has developed a two-load voluntarily opening hook. A manual control permits selection of one or both of the two enclosed springs so as to obtain prehension of 3½ or 7 pounds' force (Fig. 15).

Six years ago the commercial market for terminal devices presented a variety of hooks with variable stud screws and threads for attachment of the terminal device to the artificial arm. Since then, a standard stud thread of ½-20 has been established. The shapes of the split hook fingers are becoming

more standardized. The Government's program has developed the new lyre-shaped, aluminum-alloy finger with rubber-faced prehension surfaces through its contract with the College of Engineering, University of California at Los Angeles. These fingers are interchangeable for the Northrop hook and the APRL hook. The same terminal devices have also been successfully applied to braces for patients with arm paralysis. Progress, therefore, can be reported in the matter of development and improvement of terminal devices available to the seriously handicapped patient.

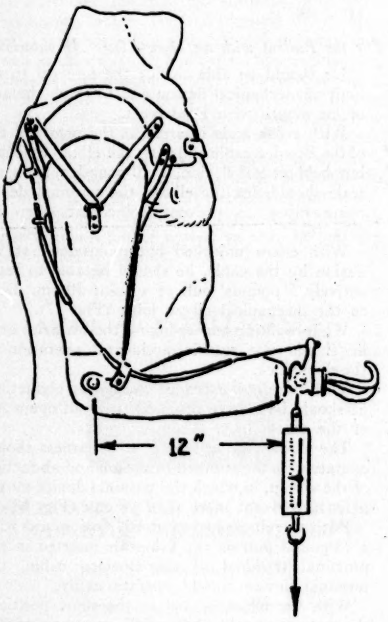


FIGURE 17. *Resistance to 5 Pounds' Pull Exerted 30 Cm. Distal to the Elbow Joint, with the Elbow Unlocked and Actively Maintained at 90° Flexion.*

It would be a serious error to leave the impression that these new arms and terminal devices are due merely to the inventors' ingenuity. Each new device in the Government's program is put through a "shakedown" test of the inventor's model. Through a contract with the College of Engineering of New York University and the facilities of the Veterans Administration Prosthetic Testing and Development Laboratory, critical testing procedures are conducted, each device being carried through "shakedown," "service" and "field" stages of testing before receiving the approval of the Advisory Committee on Artificial Limbs of the National Research Council. Even with this approval the Veterans Administration may ask for a repeated or extended field test of a device before it is finally accepted as a contract item of supply to eligible veterans. Once the device has become a contract item, it is available to the commercial civilian market.

Criteria for Acceptance of Artificial Arms

The criteria for the acceptance and final evaluation of each patient fitted with an upper-extremity prosthesis deserve emphasis. After preliminary evaluation the patient must be trained in the technics of operating his substitute arm and its terminal device. He should be able to control its operation at the level of his belt buckle and at the level of his mouth. The following simple series of tests have been devised by the University of California at Los Angeles[14]:

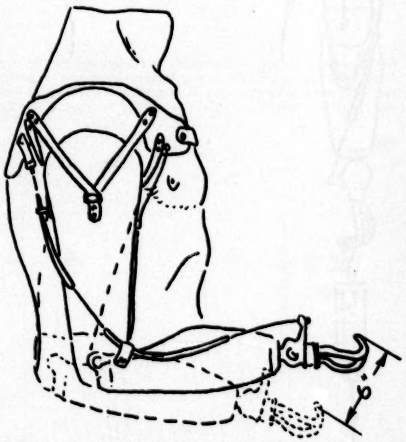


FIGURE 18. *Terminal-Device Movement in Operation of the Elbow Lock (Arc of Motion Should Not Exceed 15 Cm.).*

For the Patient with a below-Elbow Amputation

He should be able to flex the elbow to the same degree with and without the prosthesis.

At a distance of 30 cm. distal to the lateral humeral epicondyle with the hook fingers taped together, he should be able to withstand a 5-pound weight without motion of the socket about the stump, the elbow being maintained at 90° flexion.

With his hook loaded to 6 pounds' finger-tip grip, he should be able to attain full operation of the hook fingers with a 25-pound pull (as measured by an inserted fish scale) on the proximal end of the Bowden cable.

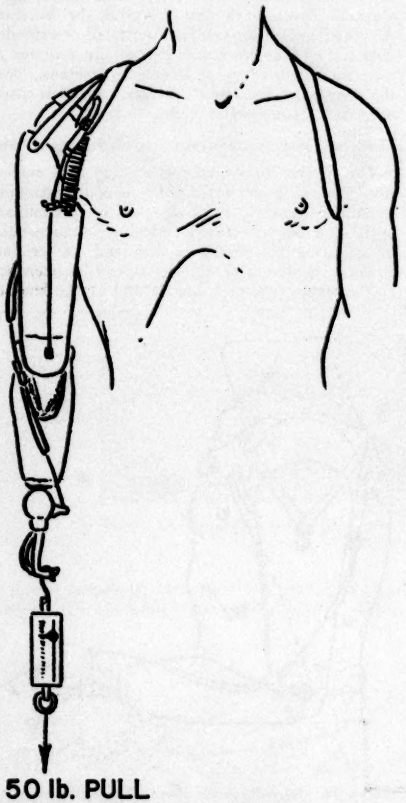


FIGURE 19. *Elbow Extension, with Arm at Side, under 50-Pound Pull.*
Suspension of the prosthesis must be adequate to prevent slippage off the stump of more than 2.5 cm.

He should be able to operate the terminal device fully at full flexion at the level of the mouth as well as at the 90° flexion level or belt-buckle line.

The patient with a medium or long stump, without synostosis, when the elbow is flexed at 90°, should be able to pronate and supinate about 75 per cent of what is available with extended elbow.

With the elbow in extension, he should be able to withstand a 50-pound pull on the terminal device without slippage of the socket on the amputation stump of more than 2.5 cm.

With the elbow flexed at 90° the stump should be able to withstand, without discomfort, pressure exerted on the terminal device by both hands of the examiner pressing along the axis of the forearm.

For the Patient with an above-Elbow Amputation

He should be able to flex the forearm to the limit of mechanical flexion and to reach the area of his mouth with head erect.

With a fish scale inserted at the proximal end of the Bowden cable and with the elbow unlocked but held at 90° flexion, a 10-pound pull on the scale should flex the elbow, the terminal device being taped to prevent coincident operation (Fig. 16).

With elbow unlocked but maintained at 90° flexion by the cable, he should be able to resist actively 5 pounds' pull at a point 30 cm. distal to the mechanical elbow joint (Fig. 17).

While walking and swinging the artificial arm, he should not sustain accidental operation of the elbow lock.

With the elbow extended and during abduction, he should be able to reach 60° without operation of the elbow lock.

The elbow lock and its control harness should operate with a combined extension and abduction of the stump, in which the terminal device moves in an arc of not more than 15 cm. (Fig. 18).

With the elbow locked at 90° flexion and with a 25-pound pull on the fish scale inserted in the proximal terminal of the Bowden cable, the terminal device should operate easily.

With the elbow locked in the same position, the patient should obtain full operation of the terminal device.

With the elbow locked at the level of the mouth and of the belt buckle, he should be able to manipulate the terminal device to at least 50 per cent of full operation.

In determining the potential of use of a prosthesis in abduction, the length of the stump and shoulder-joint function must be adequate.

With the stump flexed at 90° and the elbow locked at 90°, the patient with above-elbow amputation should be able voluntarily to rotate his prosthetic forearm a reasonable degree without slippage of the socket on the stump.

In elbow extension with the arm at the side, a 50-pound pull on the terminal device should not cause discomfort or more than 2.5-cm. slippage of the prosthesis from the stump (Fig. 19).

With the prosthetic elbow locked at 90°, the examiner should be able to push the prosthesis with both his hands in the axis of the humerus without causing stump pain or discomfort.

Discussion

It is recognized, in these days of specialization, that only through dissemination of information are new developments and new procedures adopted by the medical profession. With the space and time permitted, it has been possible to enumerate and describe some of the advances that have resulted from extended research by surgeons, engineers, physiologists, limb fitters, and physical and occupational therapists. The research and development, as well as the designing and production engineering, of these devices take much time. For these seriously disabled patients to receive the best in the way of prosthetic appliances, the surgeon should know how to prescribe properly the most useful devices. It is not enough to refer the patients to the limb fitter. Responsible surgeons have an obligation to determine that the patient receives — and maintains — the best available prosthesis with its efficient transmission of power, so that he can live a two-handed existence.

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MEDICAL INTELLIGENCE

CHILLS AND FEVER DUE TO PROCAINE AMIDE HYDROCHLORIDE THERAPY*

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NEW HAVEN, CONNECTICUT

THE value of procaine amide hydrochloride in the treatment of various cardiac arrhythmias, particularly those of ventricular origin, has been well established. Attention has been called to certain undesirable side effects of the drug, including occasional hypotension after its intravenous administration and nausea, vomiting, mental confusion and profuse sweating attending its oral use.[1-3] Recently, Leibowitz[4] and Bakos and Askey[5] have described striking febrile reactions in patients given procaine amide orally. It is the purpose of the present report to describe another case of drug fever due to procaine amide hydrochloride.

Case Report

H. B. a 57-year-old man, was admitted to the New Haven Hospital on June 17, 1952, with the signs and symptoms of an acute myocardial infarct. Significant facts in the patient's past history included the following: a probable myocardial infarct 5 months previously; a cerebrovascular accident 1 year before; the existence of hypertension for several years; and no history of previous allergy or hypersensitivity, although on prior occasions the patient had received both penicillin and procaine.

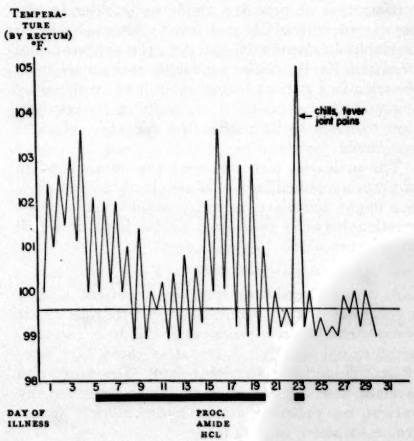

FIGURE 1. *Temperature during the Hospital Course.*

The temperature was 100°F., the pulse 70 and irregular, and the blood pressure 110/85. No signs of pulmonary congestion were present; there was a slight residual left hemiparesis.

Examination of the blood showed a white-cell count of 12,200; serial electrocardiograms demonstrated auricular

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fibrillation and changes compatible with posterior myocardial infarction.

The patient was treated with oxygen, morphine and atropine. Slight chest pain and mild hypotension persisted for the first 48 hours of hospitalization. The patient's temperature ranged from 100 to 103°F. during the first few days.

On the 5th hospital day, ventricular tachycardia developed suddenly and was controlled by intravenous injection of procaine amide hydrochloride. The patient was digitalized because of the development of basilar rales and, in addition, maintained on 0.5 gm. of procaine amide orally every 4 hours.

Rhythm remained regular, and no further signs of cardiac decompensation developed, but fever persisted, the temperature ranging from 101 to 102°F. (Fig. 1); the patient complained bitterly of headache, malaise and anorexia. On the 8th hospital day, because of the unexplained fever, procaine penicillin was begun. Within 24 hours, an urticarial rash developed, subsiding promptly when the procaine penicillin was discontinued. However, systemic symptoms and fever persisted. No evidence of thromboembolic complications was found, and repeated cultures of blood and urine were negative.

On the 20th day the procaine amide was discontinued. This was followed by prompt defervescence and a striking subjective improvement. After the temperature had been normal for 72 hours, a "test" dose of 0.5 gm. of procaine amide was administered orally. This was followed by a shaking chill with a temperature of 105°F., and the headache, nausea and joint pains recurred. These symptoms all subsided within 8 hours.

The remainder of the hospital course was uneventful. An intradermal skin test with 0.1 mg. of procaine amide and a "patch test" were both negative. The patient was discharged asymptomatic on the 31st hospital day.

Discussion

This case is similar to those reported by Leibowitz[4] and by Bakos and Askey[5] in which oral administration of procaine amide hydrochloride was associated with chills and fever. Although this is probably an uncommon reaction, the appearance of persistent fever, chills, headache, rash, malaise or anorexia in a patient being maintained on this drug suggests the advisability of stopping the medication to evaluate its role in the causation of these symptoms.

The urticarial rash following the administration of procaine penicillin in this case is of interest since one might speculate on the possibility of a cross-reaction between these two drugs, both of which contain procaine.

Summary

A case of persistent fever in a patient with a myocardial infarct maintained on procaine amide is reported. Upon withdrawal of the drug, the temperature fell rapidly. A test dose three days later caused chills, fever and joint pain. The suggestion is made that persistent unexplained fever in any patient on procaine amide hydrochloride should arouse suspicion of drug fever.

70 Central Avenue

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CHOLERESIS IN HYPERACIDITY AND PEPTIC ULCER

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BOSTON

THE following brief discussion is a statement of an item of unfinished business that I believe deserves to be recalled to attention. I realize that it is old rather than new material, but it is my conviction that its revival will enable family physicians to give relief to innumerable patients.

The synthesis and secretion of inorganic hydrochloric acid by the stomach is a unique process in physiology. Normally, hydrochloric acid with pepsin institutes the digestion of proteins in the stomach, and the acid product is passed through the pylorus into the duodenum, where it is promptly neutralized. Normally this occurs without sensation, but abnormally, in acid indigestion or hyperacidity, there is delay in this discharge, with resulting discomfort, relieved by sodium bicarbonate or other antacids. When persistent this abnormality of discharge is undoubtedly a factor in the development of peptic ulcer and it therefore deserves study with a view to its possible correction.

Cannon,[1] in 1912, evolved a conception of the behavior of the pylorus that, although generally rejected by physiologists, is suggestively consistent with the clinical phenomena. He believed that the appearance of acid on the gastric side was the first signal for the pylorus to open and to pass a jet of acid contents into the duodenum. The pylorus then closed until the jet of acid contents in the duodenum was converted to neutrality or alkalinity. Then, if the gastric content was still acid, the pylorus opened again, and the process was repeated.

Later studies of the action of the pylorus have disclosed inconsistencies with Cannon's theory. It is clear that when water and other fluids enter the fasting stomach the pylorus is open and remains open to allow their free passage. McClure showed that acid introduced experimentally into the duodenum was not inconsistent with opening of the pylorus. It has been demonstrated that pressure applied on either the gastric or the pyloric side of the pylorus may cause it to open, and gastric peristalsis as a factor in the emptying of the stomach has been emphasized. Psychic influences may have effects. But these experimental observations involved somewhat abnormal conditions. It still seems possible that in normal, comfortable digestion Cannon's mechanism holds. In an address in 1934 he[2] did not definitely retract it. And certainly, in the numerous patients who regurgitate strong acid and take soda for relief, failure of this mechanism by delay of duodenal neutralization is a plausible explanation.

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Obviously, for the digestion of a meal, whether Cannon's theory is held or not, there must be a total of duodenal alkalinizing material equal to the total of gastric acid secreted for that meal. The alkalinization of this large amount of gastric acid has received curiously little study.

Treatment of hyperacidity has been directed almost entirely to neutralization of excess hydrochloric acid in the stomach by antacids, and attempts to reduce its formation by diets and other influences, without regard for what must be the normal process of neutralization or alkalinization.

This alkalinization has been attributed to pancreatic juice, succus entericus and bile, especially the first since it is the most strongly alkaline. But it is hard to believe that the amounts of pancreatic juice and succus entericus are enough to equal the great volume of gastric hydrochloric acid, and there is reason to suspect that the bile, although it is weakly alkaline but is of large amount, may play a more important role than has been given it.

Moreover, although no way of increasing the pancreatic secretion or the succus entericus is known, Dr. Franz Pfaff, professor of pharmacology at Harvard Medical School, showed fifty years ago that the amount of bile may be increased materially by the administration of inspissated animal bile in such a way that it will not irritate the stomach but will be absorbed from the intestine, carried to the liver and re-excreted as an addition to the previous bile flow.

Thinking of Cannon's finding that in normal digestion when the stomach discharged a jet of acid contents into the duodenum the pylorus closed and remained closed until the acid was neutralized in a normal manner led me to wonder whether common acid indigestion or hyperacidity was not due to such pyloric closure because of deficient duodenal neutralization, and it further occurred to me that one might improve this duodenal neutralization by increasing the bile flow by giving Pfaff's salol-coated pills of inspissated bile.

Accordingly, with patients in the Outpatient Department of the Boston City Hospital and some private patients, I made a trial of giving Dr. Pfaff's bile pills, with uniformly favorable results. This I reported, perhaps with some excess of youthful enthusiasm.[3] By a strange coincidence Glaessner,[4] of Vienna, reported practically the same observation some months later in the same year. I have mentioned this in more general articles and in a book.[5] But although this treatment, from its empirical usefulness in practice, continued to have a certain vogue (the late Dr. George R. Minot, shortly before his retirement, told me that he believed that he had "prescribed a barrel-full of these bile pills," and the late Dr. Ralph Larrabee said that he never went on camping trips without a supply of them as antidotes for the frying-pan diet), its use seems never to have gained recognition in general therapeutic teachings.

One probable reason is that most pills of bile or bile salts are inadequately coated for enteric absorption and so irritate the stomach. Tablets Glycotauro,* which Dr. Minot used, are an exception. More recently combinations of bile salts and bile acids have been put out, such as Supligol tablets.† The last are not too well coated, but administration half an hour before meals with a glass of water has not produced gastric irritation. I have given 2 or 3 tablets three times a day for a week, followed by a gradual reduction in dose, with quite regularly a lessening of the need for antacid taking.

In a few cases of early duodenal ulcer with positive x-ray evidence the same treatment has given rapid symptomatic relief, with normal x-ray films a month later. In some bed-ridden patients on routine treatment I have thought that this treatment in addition may have helped. More generally, however, in severe chronic ulcer when surgery is being considered, it has been ineffectual. Its chief usefulness is therefore in supposedly functional hyperacidity and perhaps in the prophylaxis and early treatment of peptic ulcer.

At present I am no longer able to conduct any systematic study, but hope intensely that the subject may be reopened.

*Available from Hynson, Westcott and Dunning, Incorporated, Baltimore.

†Available from the American Ferment Company.

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Correction. In the right-hand section of the diagram in the Medical Intelligence article entitled "Swimmer's Muscle Cramps," by Dr. Wyman Richardson, which appeared in the November 20 issue of the *Journal*, the words "Carbon Monoxide Deficiency" should be changed to read "Carbon Dioxide Deficiency."

CASE RECORDS OF THE MASSACHUSETTS GENERAL HOSPITAL

Weekly Clinicopathological Exercises

FOUNDED BY RICHARD C. CABOT

BENJAMIN CASTLEMAN, M.D., *Editor*

VIRGINIA W. TOWNE, *Assistant Editor*

CASE 38521

PRESENTATION OF CASE

First admission. A fifteen-year-old girl was admitted to the hospital because of severe frontoparietal headaches, vomiting and loss of vision, beginning about four months before entry. The headaches were accompanied by forceful vomiting, apparently without nausea, were aggravated by walking about and were somewhat relieved by lying down. The headaches occurred with increasing frequency, becoming almost constant by the time of admission. Three weeks before entry, she had a particularly severe headache intensified by any movement of the head, during which there was projectile vomiting, and retraction of the head. The temperature was normal and symptoms disappeared after a few hours in bed, but after this she was drowsier than usual. One week later, she began to complain of ringing in the left ear. She became increasingly irritable. One week before entry, upon arising in the morning, she said she could not see well. During the next few days vision became progressively worse, and she was brought to the hospital.

The patient's birth and early development were not remarkable. As a child she had had chicken pox, mumps, measles and pertussis without serious incident. There had been no head injuries. The menarche had occurred at the age of twelve, and the periods had been normal until the present illness, when the flow became scanty. For several years, she had grown rapidly and was "underweight." Because of this and scholastic difficulties, she was taken out of school one and a half years before entry.

On physical examination, the patient was drowsy, vomited, held her head stiffly in a retracted position, and complained of a left frontoparietal headache. She appeared poorly nourished, and looked younger than her stated age. At the time of admission, she was blind in both eyes, and the pupils were bilaterally 4 mm. in diameter and unreactive to light, but on the following morning, when her general condition was somewhat improved, inconstant light perception was found in the right eye and a visual acuity of 5/200 in the left eye. Examination of the visual fields at that time showed marked peripheral constriction and suggested a nasal hemianopia on the left; the field of the right eye could not be adequately tested. There was bilateral papilledema of about 3 diopters, with pallor of the right disk. Hearing was slightly impaired in the right ear, and on the Weber test, the tuning fork was best heard in the left ear. The cranial nerves were otherwise unremarkable. There were no abnormalities of the motor system. Tendon reflexes were generally sluggish, but brisker in the left leg than in the right. The right plantar reflex was flexor, and the left equivocal. There were no sensory changes. The examination was otherwise within normal limits.

The temperature and blood pressure were normal, and the pulse was 100. Urine and blood studies were negative.

In the hospital ventriculography demonstrated marked dilatation of the lateral and third ventricles, especially of the posterior horns of the lateral ventricles. The posterior part of the third ventricle and the aqueduct and fourth ventricle were not demonstrated. The upper part of the anterior horns were more widely separated from each other than usual. A cerebellar exploration was done, at which the cerebellum was found to be under great tension although the hemispheres felt normal. A catheter was passed via the fourth ventricle along the aqueduct for about 13 cm., where it stopped. Fluid and air injected into the lateral ventricles were thought to appear at the fourth ventricle. The patient returned to the ward in good condition. X-ray treatment totaling 1600 r was given postoperatively over an eight-day period, divided among the frontal lobe, the vertex and the suboccipital region. Meanwhile, there was a further loss of vision. At the time of discharge, on the twenty-seventh postoperative day, the right eye was totally blind, and there was only light perception in the left eye. The right pupil did not react to light, and the left reacted only slowly. The remainder of the neurologic examination was unremarkable.

Subsequently, the patient was followed in the Out-Patient Clinic. Eight months after discharge, she was found to have no vision in either eye, and the pupils did not react to light. Papilledema was no longer present, but there was bilateral optic atrophy. A lumbar puncture revealed clear spinal fluid, under a pressure equivalent to 200 mm. of water, containing 2 lymphocytes per cubic millimeter and a total protein of 49 mg. per 100 cc. Otherwise, she remained in excellent health until four years later, when she had started to have attacks of impaired consciousness lasting a few seconds at a time, in which she saw flashes of yellow light and

was unable to hear what was said to her. In a more severe attack, later that year, she fell and bruised her hip. An electroencephalogram showed a bilaterally abnormal record characterized by slow waves and wave spikes. In the following year, she began having generalized convulsions in which she first saw flashes of light "in the left eye," with convulsive activity beginning in the left arm.

Final admission (ten years later, at the age of thirty). In the interval, the patient had had occasional seizures, but had got along fairly well, learning to read Braille and to work at weaving. Seven months before entry, the seizures began to be more frequent, finally occurring once or more often daily. These were described as lapses of consciousness for ten to fifteen minutes, with no convulsive movements. Five hours before admission the patient cried out and was found unconscious with thrashing movements of the left arm lasting one and a half hours, followed by rapid opening and closing movements of the left hand for two hours. The patient remained unresponsive and was brought to the hospital.

On physical examination, she was semicomatose. She was able to move the right arm and leg on command, but the left arm and leg were flaccid and motionless. The fundi showed optic atrophy. The right eye was abducted, and there were wandering movements of both eyes to the right, but neither eye crossed the midline to the left, and there were no upward movements, either spontaneously or on flexion of the head. The pupils were 4 mm. in diameter and were fixed. It was thought that she reacted less vigorously to pinpricks on the left side. The tendon reflexes were sluggish, and approximately equal except that the left knee and ankle jerks were slightly brisker than the right. The plantar reflexes could not be obtained. There was a slight erythematous rash on the face and nose and around the eyes. The physical examination was otherwise unremarkable.

The temperature was 103.5°F., the pulse 125, and the respirations 32. The blood pressure was 84 systolic, 62 diastolic.

The blood hemoglobin was 14.5 gm., and the white-cell count 27,900, with 90 per cent neutrophils, 8 per cent lymphocytes and 2 per cent monocytes. The urine gave a +++ reaction for albumin; the sediment contained occasional granular casts.

In the hospital continuous jerking movements of the left arm and leg and of the face and neck muscles bilaterally developed. The temperature rose to 105°F., and the patient died fifteen hours after admission. A lumbar puncture performed post mortem showed 3 to 5 lymphocytes per cubic millimeter, a total protein of 52 mg. per 100 cc. and a normal gold-sol curve.

Differential Diagnosis

Dr. Raymond D. Adams*: William Gowers,[1] in his admirable monograph, states that "the subject of the diagnosis of disease. . .certainly transcends in complexity, and perhaps exceeds in interest, all other problems in practical medicine." Those who regularly attend these exercises must surely concur in this opinion. For my part, I must confide that while struggling with this case last evening I found myself in sympathy with Gowers concerning the complexity of diagnosis.

The clinical data with which I am presented lead unmistakably to the conclusion that this patient suffered from a brain tumor. The frontoparietal headaches, the forceful vomiting and the papilledema, or "double optic neuritis" as it was formerly called, are the commonly accepted signs of increased intracranial pressure. Of course, one must at once consider syndromes that simulate brain tumor, so-called pseudotumor syndromes, such as thrombosis of the superior sagittal sinus, aqueductal stenosis and chronic arachnoiditis, but I shall dismiss these possibilities at the moment because they are usually diagnosed only by the exclusion of all other diseases.

This part of the clinical problem is straightforward, but I am sure that Dr. Castleman and Dr. Richardson would not accept such a simple formulation of the case. They require, as all clinicians do, two additional facts in a suspected case of intracranial tumor: one is the location of the lesion, and the other is its nature.

Regarding the location of this pathologic process I must depend on the other clinical and laboratory data. It is noteworthy that focalizing or lateralizing signs were slight or absent. There was no paralysis of the limbs, crude sensory defect or aphasia. In a young person with signs of increased intracranial pressure and no conspicuous lateralizing signs one always thinks first of tumor of the cerebellum, the fourth ventricle or third ventricle, or of hydrocephalus due to congenital or inflammatory stenosis of the aqueduct of Sylvius or a chronic meningitis (adhesive arachnoiditis).

Of the other clinical phenomena, the blindness was probably the most striking finding. It could have been due to a suprasellar craniopharyngioma pressing directly on the optic chiasm. However, the onset relatively late in the course of the illness, some months after headache, the rapid progression of visual impairment, the presence of papilledema with minimal atrophy of optic disks and the constricted visual fields are all characteristic of optic atrophy consequent to high intracranial pressure and papilledema. Thus, blindness provides no certain clue to localization.

The retraction of the head, the intensification of headache on any movement of the head and the

*Chief, Neurology Service, Massachusetts General Hospital.

stiff neck suggest a threatening cerebellar herniation, though at operation some days later the cerebellar hemispheres were said only to be full and hernia was not mentioned. The drowsiness and slowness of response could be explained by high intracranial pressure. Again, these symptoms lack localizing value. The ringing in the left ear and the impairment of hearing are of interest, pointing to a disturbance of the eighth nerve or cochlea, but without other signs of disease in this region, one seeks alternative explanations. Bilateral impairment of hearing may be due to a lesion of the inferior colliculi and often occurs in pinealoma. May I ask about hearing in the right ear? Was an audiogram done?

DR. EDWARD P. RICHARDSON, JR.: No.

DR. ADAMS: Were ocular movements recorded?

DR. RICHARDSON: They were not described in greater detail than appears in the protocol.

DR. ADAMS: Limitation of upward gaze was not noted until the last illness. Did the pupils constrict on attempted convergence?

DR. RICHARDSON: That was not mentioned.

DR. ADAMS: Was the patient able to stand and walk, and was there an ataxia of gait at that time?

DR. RICHARDSON: No such observation was mentioned.

DR. ADAMS: I would attach importance to what I assume was the normal physical development and regular menses up to the time of hospital entry and the lack of polyuria or polydypsia, obesity or precocious puberty. Slight pyramidal-tract signs were present on the left but were not sufficiently prominent to be helpful.

May I see the x-ray films?

DR. JOSEPH HANELIN: They are not available.

DR. ADAMS: I was going to ask if there was intracranial calcification; if the sella turcica was flattened or enlarged; if the clinoid processes were decalcified; and if there was any sign of a mass occupying the posterior part of the third ventricle.

DR. BENJAMIN CASTLEMAN: The following is a report of the plain skull films:

> There is marked increase in the convolutional markings, and separation of the suture lines. The dorsum sella, as well as the floor of the sella, is gone. The findings are those of marked intracranial pressure without localizing signs.

DR. ADAMS: The ventriculogram and subsequent operative exploration of the posterior cranial fossa tell me that the cerebellum was normal and that the fourth ventricle and aqueduct of Sylvius were patent for 13 cm. Do you measure that from the obex of the medulla?

DR. JAMES C. WHITE: It is about 6 cm. from the obex to the third ventricle. The tip of the catheter presumably passed upward through the foramen of Monro and entered the lateral ventricle.

DR. ADAMS: Does that not extend far beyond the aqueduct?

DR. WHITE: Yes.

DR. ADAMS: That is surprising. I may assume, therefore, that the hydrocephalus that was demonstrated was due to an obstruction of the third ventricle, and I must consider the differential diagnosis of benign tumors presenting in the third ventricle. These are suprasellar craniopharyngioma, colloid cyst and pinealoma.

It is difficult to distinguish these tumors on clinical grounds alone. For this I have the authority of Dandy,[2] whose large experience with this group of tumors was summarized in a small monograph. He states that "tumors of the third ventricle usually cause advanced pressure but with few exceptions produce no accurate localizing signs. All efforts to develop a diagnostic syndrome of neurological signs and symptoms have been unsuccessful." Yet he concedes that there are several findings that lead to suspicion: for the suprasellar craniopharyngioma, onset often in children and adolescents, visual disturbance (bitemporal hemianopia or other field defects), headache and vomiting, retardation in growth and sexual development and suprasellar calcification; for the colloid cyst and other benign intraventricular tumors, onset of colloid cyst in adult life, other tumors at any time, headache and mental deterioration, blindness and ataxia later, episodic headache with blindness and bilateral paresthesias and weakess of legs, at times influenced by posture; and for the pinealoma, onset in childhood, adolescence and adult life, headache and vomiting, paralysis of upward gaze, dilated fixed, often unequal pupils, abnormal movements of limbs (that is, chorea or ataxia of trunk and limbs), bilateral impairment of hearing, occasionally sexual precocity and blindness late in illness.

Since I have not heard of or seen a colloid cyst in a fifteen-year-old person, the differential diagnosis is between the other two lesions. There were no crucial data that permit a definite diagnosis of either pinealoma or craniopharyngioma. In favor of pinealoma is good response to x-ray therapy, failure of posterior part of the third ventricle to fill, tinnitus and deafness and relatively late affection of vision.

I assume that the neurosurgeons made a diagnosis of pinealoma, for they gave x-ray treatment and made no attempt to operate. Most neurosurgeons regard the pinealoma as inoperable. Evidently, the hydrocephalus was relieved either as a result of x-ray therapy or by some other means, and the patient did well for several years.

The seizures that occurred in the last ten years of life were surely due to a supratentorial lesion. Was it the result of the puncture lesions created by ventriculography, or had the tumor enlarged and encroached upon adjacent parts of parietal and occipital lobes? I cannot decide on this. I believe we have seen cases at autopsy in which the scar of ventricular punctures was the only explanation of epilepsy. Of interest are the flashes of light in the

left eye — which indicated that the lesion involved visual structures in the right cerebral hemisphere, probably the occipital lobe. By central excitation of visual centers or pathways these flashes of light could occur even though the patient was blind from disease of the optic nerves, an unusual circumstance.

I think the differential diagnoses are suprasellar craniopharyngioma, colloid cyst and pinealoma, all of which can cause flattening and enlargement of the roof of the anterior part of the third ventricle, with pressure on the sella and its contents. I take it there was some erosion, which could have been due to increase in the intracranial pressure with no great enlargement of the sella, no destruction of the tissue and no calcification. The best I can do with this is to exclude the pseudotumor syndromes, a diagnosis that one arrives at almost by a process of exclusion, and make a positive diagnosis of a third-ventricle tumor. I should favor pinealoma over craniopharyngioma. I should expect that there was some degree of hydrocephalus but that it was not the cause of death. I expect that the tumor that will be demonstrated did not seriously obstruct cerebrospinal-fluid circulation.

Death was, in my opinion, due to status epilepticus. Until this last series of convulsions we must assume that the patient was using the left arm and leg properly, was not having headaches and was not deteriorating mentally. In her comatose state the failure to move the left arm and leg could have been due either to a postepileptic paralysis or to a slight motor deficit that had existed since the first admission and had become manifest during coma. The fever and leukocytosis can be attributed to the seizures.

Dr. White: At the time that we took the ventriculograms we could not be sure that the questionable defect in the posterior portion of the third ventricle was not caused by incomplete air filling and that disease in the fourth ventricle could be excluded; that was why the exploration was done. No abnormality was found there. We thought the patient had a tumor lying either in the brain stem just below the third ventricle or just above the aqueduct in the region of the pineal body; that is why she was given x-ray treatment.

Dr. Adams: The posterior part of the third ventricle was not well visualized.

Dr. White: The anterior part was, so that one ought to be able to rule out a third-ventricle cyst, which is always situated at its rostral end, but that does not rule out a lesion posteriorly around the aqueduct.

Dr. Jacob Lerman: I should like to ask Dr. Adams if the note that the menstrual flow became scanty and the note about the growth might not mean something — that in some cases it might point to the site of the tumor.

Dr. Adams: With pinealoma in both males and females there may be a precocious sexual development; puberty may occur as early as six to nine years of age. Also, there are occasional cases in which there is merely a general overgrowth of skeleton. The usual effect of a suprasellar craniopharyngioma beginning in the prepubertal child is to retard sexual development and delay menses or prevent them from appearing at all. The clinical picture is one of general infantilism or obesity, with lack of sexual development. Scant menstruation in the last months of life would be difficult to interpret.

Clinical Diagnoses

Brain tumor, ?brain stem, ?roof of third ventricle.
Status epilepticus.

Dr. Adams' Diagnoses

Pinealoma, with obstructive hydrocephalus and consecutive optic atrophy.
Status epilepticus.

Anatomical Diagnoses

Pinealoma, astrocytomatous form.
Optic atrophy, bilateral.
Congenital absence of corpus callosum.
(*Status epilepticus.*)

Pathological Discussion

Dr. Castleman: Of course, the main findings were in the head; the remainder of the examination showed only pulmonary edema and congestion.

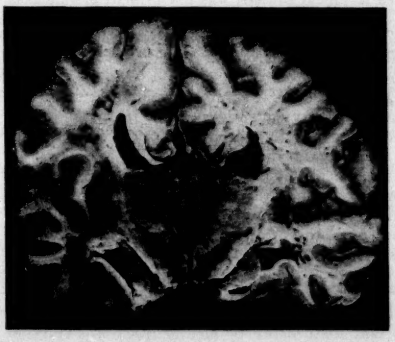

Figure 1. *Coronal Section of the Brain Passing through the Mid-Thalamus.*
The tumor is within the third ventricle. The defect in the corpus callosum is clearly visible.

The cerebral findings will be discussed by Dr. Richardson.

Dr. Richardson: There was a tumor of the pineal body measuring about 2 by 3 cm., a smoothly rounded mass so situated that it displaced the posterior commissure somewhat downward and pressed lightly on the quadrigeminal plate. A tongue of the tumor tissue projected downward for a short dis-

tance into the cerebral aqueduct, and a considerable portion of the tumor bulged forward into the lumen of the third ventricle (Fig. 1). In addition, there was marked downward bulging and thinning of the floor of the third ventricle, and both optic nerves and the optic chiasm were stretched and were severely atrophied. Another striking finding in this case was complete absence of the corpus callosum. In its place, there was a thin, membranous structure, apparently devoid of nervous tissue, that formed the roof of the lateral ventricles in the normal location of the corpus callosum. There was also marked dilatation of the ventricular system, particularly of the occipital horns. At lower levels, the aqueduct, fourth ventricle and brain stem were normal.

Microscopically, this tumor was made up of cells that varied to a considerable extent in size but in general were of the same type. Some were round; some were fusiform, with abundant fibrous processes staining in a manner identical to that of glial fibers. No mitoses were seen. The microscopical appearance of the tumor in general suggested a form of astrocytoma. In one section, there was an island of tissue that was similar in structure to the normal pineal body. The widespread presence of glial fibers in the tumor led us to believe that it was a glioma. The structure was too uniform for a teratoma. The combination of groups of large cells and masses of small cells resembling lymphocytes, often seen in pineal tumors, was not present in this case. We were unable to discover any lesion to which the convulsive seizures might with certainty be attributed. Sections of the cerebral cortex disclosed no abnormalities.

DR. ADAMS: Is it your impression that death was due to status epilepticus rather than something that happened to the patient?

DR. RICHARDSON: Yes.

DR. ALLEN G. BRAILEY: Was the absence of the corpus callosum congenital?

DR. RICHARDSON: We believe it was congenital and represented a failure in development that was totally unrelated to the later events.

DR. ADAMS: One of the startling discoveries made in the last few years has been that absence or surgical section of the corpus callosum causes no important disturbance of mental function. It is, of course, the major commissural system, between the cerebral hemispheres. Formerly, it was believed that lesions here resulted in profound dementia. Recently, the corpus callosum has been widely incised in a series of cases of epilepsy, and by the most careful tests no change in mental function has been demonstrated. It has also been observed by a number of neuropathologists that the corpus callosum may be absent in patients who have been entirely normal in every way. However, in many cases there have been mental retardation and other signs of developmental defect. The conjunction of a tumor of the pineal body, which is often teratomatous, and congenital absence of corpus callosum is noteworthy.

A PHYSICIAN: How does Dr. Adams account for the seizures?

DR. ADAMS: I shall leave that to your imagination. I do not believe this tumor accounts for seizures beginning with visual aura. I should wonder about the parietal lesion. Dr. White, do you have any explanation?

DR. WHITE: I was struck by the same situation. The patient had seizures for about ten years. Once in a while severe hydrocephalus can cause seizures, but I doubt that her hydrocephalus was sufficiently severe.

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CASE 38522

PRESENTATION OF CASE*

First admission. A sixty-seven-year-old man was admitted to the hospital because of substernal pain.

Two weeks before entry an upper respiratory infection, with coryza, rhinorrhea and a nonproductive cough, developed. A few days later there was the insidious development of substernal pain that occurred in attacks lasting twenty to thirty minutes and was not accompanied by breathlessness. At the onset the pain was dull and constricting but later became sharp and "knife-like"; the patient described it as more uncomfortable than agonizing. It had never awakened him from sleep. It originated over the xiphoid and spread cephalad to the jugular notch; on several occasions it spread down the inner aspect of the left arm, where its character was "tingling." This complex subsided over a period of a few minutes. The pain was relieved by walking around and was neither precipitated nor aggravated by exertion; the patient believed that exposure to cold had precipitated some of the attacks. Three days before admission an attack of pain occurred and persisted. On the next day his physician gave him nitroglycerin, but the pain was not relieved and persisted unchanged until admission.

There was no history of previous chest pain, dyspnea or reduction in exercise tolerance. The patient was told thirty-three years before entry and on numerous subsequent occasions that he had hypertension, but it was entirely asymptomatic. Diabetes, discovered seven years previously, was controlled by insulin for the first three years and since then by diet alone. He had had slight frequency and nocturia for several years.

*Presented at a graduate course in internal medicine.

Physical examination revealed a well developed man in no acute distress. The neck veins were not distended. The lungs were clear. The heart did not appear to be enlarged. There was a protodiastolic gallop over the entire precordium; no murmurs were heard. The apical second sound was louder than the pulmonic. A nontender liver edge was just palpable. There was no peripheral edema.

The temperature was 100°F., the pulse 106, and the respirations 20. The blood pressure was 160 systolic, 105 diastolic.

The urine had a specific gravity of 1.025 and gave a ++ reaction for albumin and a yellow sugar reaction. Examination of the blood showed a hemoglobin of 17.5 gm., a white-cell count of 15,000, with 72 per cent neutrophils, a hematocrit of 56 per cent and a sedimentation rate of 0.9 mm. per minute (uncorrected). The nonprotein nitrogen was 45 mg., the total protein 7.86 gm., and the fasting blood sugar 298 mg. per 100 cc. An electrocardiogram showed right-bundle-branch block, normal sinus rhythm at a rate of 100, a PR interval of 0.16 second, a QRS interval of 0.16 second, marked elevation of the ST segments and deep inversion of the T waves in Leads V_2, V_3 and V_4, Q waves present in Leads V_1, V_2 and V_3 and intrinsic deflection of Lead V_1 of 0.12 second.

The patient was treated by complete bed rest, Dicumarol and diet. The diabetes was easily controlled. The sedimentation rate, white-cell count and hemoglobin returned to normal, the gallop rhythm disappeared, and he was slowly ambulated in the fourth week. He was discharged on the thirtieth day symptom free, to continue on limited activity; before discharge the prostate was found to be diffusely enlarged, non-nodular, nontender and not hard.

Final admission (eleven months later). In the interval he had carried out a program of gradual ambulation, eventually returning to work. On the whole he had felt quite well, experiencing only occasional short-lasting episodes of precordial pain, usually precipitated by exertion and relieved by rest. Examination in the medical clinic seven months before admission, when he had complained of occasional chest pain, was negative; an electrocardiogram revealed that the pattern of right-bundle-branch block was still present and that since the previous tracing the T waves in Lead AVL had become upright and that the ST-segment elevation was less marked.

On the morning of admission while walking he noticed the onset of mild substernal pain, which radiated down the left arm, was not relieved by rest and persisted throughout the day. Six hours before admission the pain suddenly became more severe and was compressing in nature. He was given some pills and a "hypo," without much relief of the pain. He vomited twice shortly before admission.

Physical examination revealed a well developed man complaining of severe chest pain. The neck veins were flat. He was breathing easily, and the lungs were normal. The point of maximum impulse of the heart was 2 cm. to the left of the midclavicular line. A loud protodiastolic gallop was heard all over the precordium, being loudest at the apex. The aortic second sound was louder than the pulmonic. No murmurs or rubs were heard. The abdomen was normal. There was no peripheral edema, and the peripheral pulses were good.

The temperature was 99.4°F., the pulse 100, and the respirations 20. The blood pressure was 165 systolic, 120 diastolic.

The urine had a specific gravity of 1.027 and gave a ++ reaction for albumin and an orange sugar reaction. Examination of the blood revealed a hemoglobin of 14.5 gm. and a white-cell count of 11,350, with 85 per cent neutrophils. The nonprotein nitrogen was 26 mg., and the fasting blood sugar 170 mg. per 100 cc.; the prothrombin time was 15 seconds (normal, 14 seconds). An electrocardiogram showed no change from the previous tracing. Roentgenograms of the chest demonstrated a calcified scar in the right lower lobe and enlargement of the heart, probably in the region of the left ventricle.

The patient was treated with morphine, oxygen, diet, bed rest and Dicumarol. Mild neck-vein distention developed, and he complained of precordial discomfort on deep inspiration; the gallop rhythm improved. The prothrombin time reached an adequate therapeutic level. The temperature remained between 100 and 101°F. The diabetes was controlled with small doses of insulin. On the second day the white-cell count was 19,000, and an electrocardiogram showed that the T waves in Leads V_4 and V_5 were much taller than in the previous tracing and that a small Q wave was present in Leads V_5 and V_4. An electrocardiogram on the third day disclosed the following changes from the previous tracing: elevated ST segments in Leads 3, AVR, V_5 and V_6; Q waves present in Leads V_5, V_4 and V_6; and absent R waves in Lead V_6. On the morning of the third day examination showed a slow regular heart rate with fairly good heart sounds and no murmurs or gallops; the patient felt well subjectively except for a pleuritic type of substernal pain, which started in the subxiphoid area and moved up toward the throat. During the morning when the nurse took the blood pressure, which was 140 systolic, 90 diastolic, he seemed fine; five minutes later he was dead.

Differential Diagnosis

Dr. Victor G. Balboni*: This patient, who was sixty-seven years old, had had hypertension for thirty-three years and diabetes for seven years; therefore, he was certainly a candidate for cardio-

*Assistant in medicine, Massachusetts General Hospital.

vascular disease. His first admission, eleven months before death, was characterized by severe substernal pain. Substernal pain until proved otherwise must be considered due to coronary-artery disease. There were, however, some rather bizarre things about the substernal pain. In the first place, it was relieved by walking around, which I think is somewhat unusual but does not rule out an impending myocardial infarction. Secondly, it was not precipitated or aggravated by exertion. Such a pain suggests intermittent coronary-artery insufficiency rather than typical angina pectoris and is occasionally seen before total occlusion of a coronary artery, with resulting myocardial infarction. This is what apparently happened in the case under discussion, for after several days of the intermittent pain, severe substernal pain, typical in character and radiation of myocardial infarction, developed and he was admitted for the first time to the hospital. He did not, however, have cardiac failure, and the gallop rhythm subsided on bed rest without digitalization.

The location, radiation and character of the pain preceding his second hospital entry were typical of coronary-artery occlusion with myocardial infarction, but this time there were no preceding symptoms of coronary-artery insufficiency that warned of the impending infarction. Again, a protodiastolic gallop rhythm developed, but he seemed to be doing satisfactorily. On the third hospital day he suddenly and apparently unexpectedly died.

The record states that the prothrombin time had reached an adequate level. It was fortunate if, by the third day, the prothrombin time was well controlled by Dicumarol. He may have been one of the persons who are very sensitive to Dicumarol.

Dr. David Kahn: The prothrombin time was 29 per cent of normal.

Dr. Balboni: It should be between 10 and 30 per cent to be considered adequate.

In the differential diagnosis of chest pain, the possibilities of pulmonary embolus and dissecting aneurysm of the aorta must always be considered. In this case, however, both the attacks of pain were quite characteristic of coronary-artery disease with myocardial infarction so I do not think we have to consider these other possibilities too seriously. Although he may have had dissecting aneurysm of the aorta, I cannot make that diagnosis on the basis of the symptomatology. The pain in dissecting aneurysm of the aorta is terrific, characteristically spreads up toward the head and then down to the legs, and produces symptoms of occlusions of various branches of the aorta — because of ischemia or infarction of the kidneys, bowel and even the legs.

Having decided on the diagnosis of myocardial infarction, I am left with the problem, Why did the man die so suddenly? The possibility of a pulmonary embolus cannot be ruled out. Although he had no tender leg veins to indicate phlebothrombosis, that is not too important, for phlebothrombosis with embolization can exist with few if any signs or symptoms. Fifty per cent of patients with myocardial infarction have pulmonary emboli — or used to before anticoagulant treatment was used. Could he have had a cerebral embolus arising from the endocardium at the site of the myocardial infarction? This is possible though nothing given in the history allows me to make the diagnosis except on speculation. Most clinicians agree that adequate administration of Dicumarol reduces the incidence of phlebothrombosis, but there is some question whether the incidence of mural emboli after myocardial infarction is significantly reduced.

Before death he had some sort of queer discomfort in the precordial area, raising the possibility of a rupture of the myocardium, which is one of the complications of myocardial infarction. The third day after infarction is rather early for a myocardial rupture to occur; it usually occurs about a week later. Yet this patient had a previous infarction, and the heart had enlarged quite markedly between the first and second admissions; so it is possible that he had a markedly thinned myocardium resulting from the first infarction, possibly even an aneurysm, which ruptured easily as a result of the second myocardial infarction.

May I see the x-ray films? Can you show me the change in heart size between the two admissions?

Dr. John L. Sosman, Jr.: We do not have films of the first admission. In the films described in the protocol, there was a definitely prominent left ventricle and a somewhat tortuous aorta; there may be slight calcification of the aortic wall demonstrated in the lateral film. The scar in the right lower lobe is probably of no significance. The thoracic aorta appears to be normal, which may help eliminate a dissecting aneurysm. On the films taken on the day of the second admission there is no localized bulge or any other indication of a myocardial aneurysm.

A PHYSICIAN: What was the heart rate on the day of death? It was 100 on admission and was reported as slow and regular at the time he died.

DR. KAHN: The rate was 90 per minute on the third day.

DR. BALBONI: The gallop disappeared, and the heart sounds were quite good.

A PHYSICIAN: On the last day of life he had a slow, regular pulse and a blood pressure that had dropped.

DR. BALBONI: That is more or less what I would expect in a myocardial infarction. I do not think one can put much emphasis on the pulse; the difference is not too great in this case. Possibly, some form of heart block developed. The electrocardiogram seemed to be consistent with a myocardial infarction, probably of the anterolateral type.

I favor the diagnosis of two myocardial infarctions — the first a few days before his first entry, and the second on the day of the final admission, eleven months later. I think that the queer precordial pain felt on the day of death represented a myocardium that was perforating. We know that a perforation can bleed rather slowly, with the development of cardiac tamponade followed by death. The possibility of a cerebral embolus from a mural thrombus is a second choice as the cause of the sudden death but does not explain the chest pain.

DR. F. DENNETTE ADAMS: It seems to me that the degree of fever and the white-cell count of 19,000 in addition to an old infarction in a man who dropped dead suggest rupture. Although I never heard of anybody who died of cerebral embolus that quickly, the possibility has to be considered.

A PHYSICIAN: You made the statement that the pain preceding the first infarction was not angina but due to coronary insufficiency.

DR. BALBONI: The pain preceding an infarct is often different from that of typical angina pectoris. Not uncommonly, people have an episode of bizarre pain for a day or two before one can make a diagnosis of myocardial infarction. I recall one such patient who was down on the floor doing push-ups because they seemed to relieve the pain when nitroglycerin had no effect. Later on that day, he died of a coronary thrombosis. In these cases I picture a partially ruptured atheromatous plaque swinging free in the coronary stream and partially occluding it, causing coronary insufficiency and pain. With exercise the pressure in the coronary arteries is increased, and possibly the plaque is forced back into the wall of the artery, permitting more adequate blood flow. Of course, before long and usually within one or two days the plaque ulcerates completely, with resulting occlusion of the artery and coronary thrombosis.

DR. ADAMS: We use the term coronary insufficiency to cover the middle ground between known coronary thrombosis with myocardial infarction and spasmodic angina. Some physicians believe that some of those attacks in which a patient is sick for six hours with pain and recovers are probably due to a mild form of thrombosis, whereas others call it a temporary ischemia. I subscribe to the former.

A PHYSICIAN: Did you localize the infarction?

DR. BALBONI: The electrocardiogram as I read and interpreted it was diagnostic of a myocardial infarction in the anterolateral portion of the left ventricle.

DR. ADAMS: I should like to say that if the patient had enough myocardial damage to do all that, he would also have had some pericarditis.

CLINICAL DIAGNOSES

Myocardial infarction.
?Myocardial rupture.
?Pulmonary embolus.

DR. BALBONI'S DIAGNOSIS

Myocardial infarct of anterior portion of left ventricle, with perforation and cardiac tamponade.
?Cerebral embolus.

ANATOMICAL DIAGNOSES

Myocardial infarct, recent, with rupture and cardiac tamponade.
Hemopericardium.
Cardiac hypertrophy, hypertensive type.
Myocardial infarct, old.
Coronary thrombosis, recent.
Coronary arteriosclerosis, severe.
(Diabetes mellitus), with hyalinization of islands of Langerhans.

PATHOLOGICAL DISCUSSION

DR. KAHN: At autopsy we found the pericardial sac distended by 400 to 500 cc. of blood and blood clot. When the blood was cleared away, we found, on the posterolateral surface of the left ventricle, an area of softening measuring approximately 5 cm. in diameter in the center of which was a small,

ragged tear in the epicardium; from this a jagged sinus tract extended through the myocardium to the endocardial surface. Histologic examination showed a myocardial infarct that involved the whole thickness of the wall; the muscle was necrotic, there was a marked acute inflammatory exudate, and there was increased vascularity — findings consistent with an infarct of three or four days' duration. The heart was definitely enlarged, weighing 550 gm., and the left ventricle was hypertrophied, as would be expected with the long-standing hypertension. In addition, an old myocardial infarct was found on the anterior wall of the left ventricle; here the myocardium was fibrotic and thinned out. There was severe coronary sclerosis involving all the major branches and a recent thrombus occluded the circumflex branch of the left coronary artery a short distance beyond its origin. There was hyalinization of the islands of Langerhans in the pancreas

By far the most common cause of rupture of the heart is myocardial infarction; other causes, accounting for only a small percentage of the cases, are abscesses of the myocardium and traumatic wounds. In collected series[1, 2] approximately 8.5 per cent of myocardial infarcts have been found to terminate in rupture. The factors determining whether a rupture occurs or not appear to be a relation between the height of the intraventricular pressure and the ability of the ventricular wall to resist this pressure. Rupture is most prone to occur at a time when the infarcted myocardium is weakest — during the first week or ten days when the muscle is necrotic and healing is not yet well established. It is also most likely to occur under conditions in which the intraventricular pressure remains high after infarction, such as aortic stenosis, persistence of hypertension and exertion. In the patient under discussion the blood pressure remained elevated. Conversely, large infarcts are less prone to rupture, presumably because the myocardium is too weakened to maintain a high intraventricular pressure. Rupture into the pericardial sac is invariably fatal, usually immediately or within a few minutes and at the most within a few hours. It is interesting that after rupture through the interventricular septum, which is the least common of the myocardial ruptures, the patient may survive for several months, and in a rare case for several years.[3]

A PHYSICIAN: Do you think intrapericardial pressure had any effect on the pulse? A patient with a dissecting aneurysm and tamponade and this patient with myocardial infarct and tamponade both had slow pulses.[4]

DR. KAHN: I cannot be sure that this man had repeated small episodes of bleeding into the pericardial sac, with slowly rising intrapericardial pressure as you suggest. I should be more inclined to think that the persistent pain was due to the dissection through the myocardium and that death resulted shortly after this reached the epicardial surface. I have no explanation for the slow pulse.

A PHYSICIAN: Can you say definitely how long after trauma to the heart a rupture may be attributed to that trauma? That is important in cases of compensation. In one state, legally the rupture must show up within four days.

DR. KAHN: I am afraid I cannot answer that. We do not have any personal experience with cases of that sort, and I am not aware of any series of such cases in the literature.

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ON EXTRAORDINARY DEATHS AND MARVELOUS CURES

PHYSICIANS have a professional complex that eases the strain of their duties. If the patient dies, disease did it; if the patient is cured, they did it. This innocent projection of their ignorance and ingenuous comfort in claiming good fortune for their efforts is a habit they may have learned, like most of their art, from their patients. It is easier for a patient to say that something has happened to him than that, by his choices, he contrives his own destiny.

But seeming miracles happen still to rock one's complacency. Two were reported not long ago from what may be called opposite cultural poles. Southern California sent the account of a celebrated swami's metaphysical death. Burdened with the physical and spiritual ills of his followers, he blithely hinted at his imminent decease, asked their good wishes for his big day, attended a welcoming banquet for the new Indian Ambassador, where he made a speech concluding with a quotation from one of his verses, and promptly slipped to the floor quite dead. Mahasamadhi, it was called, or conscious exit from the body.

From the *British Medical Journal* comes the report of an equally arresting cure. A sixteen-year-old boy who had suffered from severe ichthyosis since birth, having received all the usual treatments without success, was given hypnotic suggestions, with prompt and marked improvement.

Heart attack, the doctors said of the swami. Some unsuspected psychic factor in congenital ichthyosis was suggested of the boy.

A little reflection indicates that the extraordinary and marvelous are daily experiences. A patient with heart disease dies suddenly, but at autopsy nothing is found that has not been present for weeks or months or even years. A disorder of rhythm or a chemical death, it is guessed. Many physicians have seen patients literally scared to death, more often chronically than acutely, as in certain cases of hypertension. The late DR. George Burgess Magrath, medical examiner extraordinary, is credited with the story of the man afraid of sometime being burned to death. He carried a vial of poison to forestall the pain of his immolation should he be trapped in a burning building. Eventually, he was so trapped. He was found dead and unburned, the fire having been extinguished before reaching his position in the building. His vial of poison was on his person, unused. In his "Golden Bough" Fraser recounts several examples of the lethal power of belief. One was that of the savage warrior who unwittingly ate tabooed food or touched tabooed eating utensils. Having been in excellent health until apprised of his sin, he sickened and died within the day.

On the happier side, many patients have justifiably been given a hopeless prognosis on sound clinical grounds, only to live to dance on the graves of their doctors — for instance, those with heart

disease, leukemia and pre-antibiotic infections. The patients who should have died slip from one's memory almost as easily as those who should have lived.

Does a knowing nod answer the question raised by the cancer cures at Lourdes mentioned in Carrell's *Man the Unknown*? Those afflicted in mind or spirit, one fancies, are more understandable from this point of view. Certainly, one observes patients scared to health and out of doctors' offices as their primitive terror is traced to the abyss of being. Occasionally, the less dangerous, less expensive and protracted shock of objective experience will do as well. A cured alcoholic friend said after ten days in a state hospital, "Brother, one night in Bedlam will make an altar boy out of a bum."

Imaginary agents will neither cause nor cure disease, but events in the psyche may be signs of the power or powers to which one is subject that a physician may transmit. Purpose and will and courage, and wisdom and charity in the doctor, as that wise materialist, Santayana, cautiously avers, are not irrelevant to the power of his art. One agrees with him when he intimates that materialism is not necessarily irreligious except in sophomores. Only children and philosophers seem interested in why ordinary things are, rather than are not. The rest of mankind is too busy with its real and little affairs to listen to their metaphysical questions or those of nature. Not only extraordinary deaths and marvelous cures but all the predicaments of patients, whether horrible or pleasing, in the thoughtful and detached view, beget a lively awareness of the mystery at the heart of being and lend devoutness to the traditional confession of faith: "We dress the wound, God heals it."

AN OUNCE OF PREVENTION

CERTAIN dramatic mishaps encountered in the practice of medicine and surgery, once simply accepted as acts of God, even if precipitated by some human action, are coming more and more frequently to be recognized as occurrences whose consequences may be averted by the exercise of human thought and human skill. Such an accident is death on the operating table, many cases of which are now attributable to cardiac arrest. An awareness of this complication as a major emergency has been reflected in many reports in the literature. These have usually come from the larger hospitals, making more disturbing the paper by Hinchey and Straehley appearing in this issue of the *Journal*, which presents 5 cases occurring in a community hospital in three years, 4 of them taking place within a period of six months. The question naturally arises, How often does cardiac arrest in the course of operative procedures actually occur and, more important, how often is its occurrence an avoidable complication?

Ament[1] reported 9 cases among 28,000 major operations over a three-year period at Bellevue. Johnson[2] observed 20 cases in a three-year period at the Pennsylvania Hospital, and it is of particular interest that in 8 of these cases the cardiac arrest developed after the patient had been returned to the ward. In all discussions of this subject it is generally agreed that cardiac arrest is more common than ever before. This is in part attributable to surgical procedures in or near the heart and to prolonged and difficult thoracic procedures, which must be carried out with the chest open. This is not always the case, however, and all too frequently the complication occurs during operations the magnitude of which is not calculated to disturb cardiac function.

Dinsmore[3] has emphasized the role of newer and more complicated technics of anesthesia in the production of cardiac arrest. His classic comments on this problem before the American Surgical Association in 1951 should be thoughtfully weighed by every surgeon and anesthetist:

> I feel myself that if one analyzes these cases carefully, one comes up with some common denominators. First of all the patient is met in the operating room by a man with a scalpel and another fellow with a machine with everything on it but a sledge hammer which he does not need for he has done it with drugs and agents. The patient may be given some multiple barbiturates early in the morning, followed by morphine, then by atropine, and then a little bit of pentothal for induction and actually it is easier to place an intratracheal tube in if one uses a little cocaine. Then one gives the patient some nitrous oxide, some ether or some cyclopropane and after all this one is allowed to put on the drapes. Then you start to operate and the abdominal wall is rigid and the surgeon becomes rigid and the anesthetist limp. Then the patient gets some curare! You cannot tell me that all those drugs and agents are not important factors. They simply add to a multiplicity of drugs and too deep anesthesia.

The careful study of W. Glenn Young and his associates[4] at Duke indicates one of the mechanisms

by which cardiac arrest occurs. These workers demonstrated that the heart is singularly vulnerable to vagal stimulation during periods of hypercapnia and hypoxia. Although these states are easily produced in open thoracic operations, the combination of multiple anesthetic agents and the frequent use of intratracheal anesthesia may indeed be important contributing factors that warrant intense study.

Hinchey and Straehley are to be congratulated for the brilliant application of resuscitative measures that they employed in their patients. It is indeed heartening to see how quickly technics that have been originated by specialists and might supposedly remain their province can be effectively applied by the general surgeon in the smaller community hospitals. But the treatment of cardiac arrest must not take precedence over the study of its cause and prevention. It is a condition in which a gram of prevention is worth a ton of cure. The present dictum that the most important instrument in the treatment of cardiac arrest is the knife and that massage of the heart through an open thoracotomy wound is the most successful manipulation is still true, but surely, not only will the incidence of cardiac arrest eventually be better controlled by more effective preventive measures, but simpler and more practical methods of treatment will be found.

References

1. Ament, R., Papper, E. M., and Rovenstine, E. A. Cardiac arrest during anesthesia: review of cases. *Ann. Surg.* 134:220-227, 1951.
2. Johnson, J., and Kirby, C. K. Surgical treatment of ventricular fibrillation. *Ann. Surg.* 134:672-682, 1951.
3. Dinsmore, R. S. Discussion of Johnson and Kirby.[2]
4. Young, W. G., Jr., Sealy, W. C., Harris, J., and Botwin, A. Effect of hypercapnia and hypoxia on response of heart to vagal stimulation. *Surg., Gynec. & Obst.* 93:51-55, 1951.

FIFTEENTH ANNIVERSARY OF BLUE CROSS

The idea of spreading over a period of time any considerable expenditure of funds, and of insuring to greater or less degree against unexpected losses or expenses has long been part of the modern economic pattern. In the matter of expenditures for personal health or for individual care in the event of illness a similar concept has been more tardily accepted.

It was consequently a mere fifteen years ago and only after the overcoming of considerable opposition that Massachusetts Hospital Service — the famed Blue Cross plan of prepayment for hospital care — was incorporated in this state, the Agreement of Association being drawn up on January 19, 1937. This incorporation and the opening of the Service's doors to prospective participants followed shortly on similar actions taken in New York, New Jersey and Rochester, and had the benefit of these previous experiences.

From a membership of 10,000 achieved in December of its first year, the Blue Cross enrolment had risen to 1,957,781 in September, 1952, on the fifteenth anniversary of its opening. Since 1942 it has been associated with the still more youthful but equally vigorous Blue Shield plan — Massachusetts Medical Service — an offspring of the Massachusetts Medical Society.

ANNUAL EVENT

At the time of this writing, when nature's productive efforts have gone underground, so to speak, and a chill wind is whistling through the various notches that transect the mountain ranges of New Hampshire and Vermont, and even the less spectacular Berkshire Hills of Massachusetts, a definite comfort is provided by an annual event to which the farmers of New England have regularly looked forward for over a hundred and sixty years.

This is the appearance of the Old Farmer's Almanac(k), published continuously since 1792, first in person and more lately in spirit — for who is physically immortal? — by Robert B. Thomas, one-time resident of West Boylston, Massachusetts, and since 1846 a permanent occupant, with his wife, Hannah, of "Leg" Cemetery in Sterling. For man, too, in one way or another, must eventually go underground.

A particularly significant feature of the Almanac(k) is its unique and almost uncanny capacity of forecasting the weather for each day and almost for each hour, a full twelve months ahead. It is heartening to those who hold to the arts as opposed to the sciences to compare this undeviating accuracy with the apparently haphazard predictions of the country's most learned mete-

orologists, and the mere fifty-fifty break that they achieve, despite all their instruments of precision.

Obviously, nature knows best, and what nature, before going underground, failed to prepare in the way of weather signs, such as the length of corn tassels, the thickness of the bark on trees, the flight of wild geese and the hair on the tail of the squirrel, is not worth revealing. Unfortunately, barometric bullets in Civil War veterans' legs are becoming less and less available for the forecasting of foul weather, a fact that may be responsible for the prolonged drought of 1952.

The meat biscuits invented in Texas, are selling at a rapid rate in England, and they ought to be more highly prized at home.

Boston M. & S. J., *December 29, 1852*

BY THE LONDON POST

The Use of Hospital Beds

The Times, in a leading article, recently discussed methods of obtaining the most efficient use of hospital beds. It was pointed out that although many hospitals had long waiting lists, a Ministry of Health report revealed that in 1951, 1 bed in every 8 was normally unoccupied. Beds must be kept open for emergencies, and in teaching hospitals, where the requirements of research projects must be met, a certain wastage of bed space is inevitable. Nevertheless, an efficient turnover is essential when the cost of maintaining beds, whether occupied or not, is so high. *The Times* noted that in Canada and the United States, where the patients still pay directly for hospital care, they themselves are demanding every method to obtain the shortest possible hospital stay. Patients in this country, who pay indirectly, through taxation, are entitled to make the same demand. It is suggested that certain improvements in organization could help. More x-ray studies and other investigations could be completed in the outpatient department, and the patient's admission could be more carefully timed to coincide with the specialist's hospital visits. It is also suggested that the turnover rates of hospitals could be publicized by the Ministry of Health so that the cause of widely differing rates could be examined and improvements made where possible.

There is, however, another point of view. The Minister of Health is recently reported as saying that a patient should be discharged from the hospital as soon as he is better or as soon as the purpose of his admission has been fulfilled. Although the remark might seem unnecessary, the facts that lie behind it are well known to hospital staffs. It is the disposal of patients, especially the aged or the chronically sick, that presents one of the greatest problems. The "Granny racket" was a popular newspaper topic a year or two back, when hospitals were alleged to be refusing admission to patients over seventy years because they feared they would never be able to discharge them. More homes for the convalescent and for the chronically sick are no doubt required, but one of the tragedies of the welfare state is the way in which the younger generation are tending to shelve their responsibility for elderly relatives, in the belief that their care has now become a matter for the state rather than for the family.

Dickens' Doctors

Mr. Bernard Darwin, who is probably best known as the golf correspondent of *The Times*, is also one of the greatest authorities on Charles Dickens. In delivering the Lloyd Roberts Lecture of the Royal Society of Medicine, he delighted his audience by recalling the many doctors portrayed by Dickens. Mr. Darwin suggested that Dickens knew more about medicine than the average layman of his time and that he must have liked doctors, for he made none of them such scamps as some of his lawyers like Sampson, Brass or Fogg. There was Mr. Jobling, M.R.C.S., who examined patients for the Anglo–Bengalee Insurance Company in *Martin Chuzzlewit*; Allan Woodcourt, who was a great credit to the medical profession as the hero in *Bleak House* (but nevertheless remained an even greater bore!); Dr. Lumbey, who attended Mrs. Kenwigs at her confinement in *Nicholas Nickleby*; and many others. Mr. Darwin recalled, however, that it was in *Pickwick Papers* that perhaps the greatest of Dickens' doctors were portrayed and reminded his audience how the entrance of Bob Sawyer, of St. Guy's Hospital, and Ben Allen was heralded by Sam's announcement to his master, "There's a couple o' Sawbones down stairs." Although Bob Sawyer was one of those whom Chesterton called "great creatures," some thought him a noisy, vulgar young man. He smoked in the streets, called waiters by their Christian names and drank too much. Medically, his conduct was at times not quite ethical, for he was alleged to have sent a four-ounce bottle of medicine round to half the houses in Bristol to get his name known. Perhaps as a profession we should read Dickens more than we do.

The Barber Surgeons Company

In a previous letter I mentioned the long association between the barbers and the surgeons. Until the year 1745 they were united in a joint company, and in the Thomas Vicary Lecture of the Royal College of Surgeons, Mr. Zachary Cope, F.R.C.S., recently described how the two professions parted company in that year. The prime mover in engineering the separation appears to have been William Cheselden (1688–1752). At

the age of fifteen he was apprenticed to St. Thomas' Hospital in London. There, under the teaching of William Cowper, he became keenly interested in anatomy; and in 1711 he presented a syllabus of anatomy lectures and two years later *The Anatomy of the Humane body*. This book ran to 13 English editions, two American and one German. Cheselden's lectures were so successful that he began to draw students away from the Barber Surgeons Company, and when the Court of the Company found that he had dissected a body outside the Barber–Surgeon Hall he was censured and fined £10. This, however, did not deter him and by the age of thirty he had been elected to the staff of St. Thomas' as surgeon and lithotomist, appointments that he later held at several other institutions, including the Westminster and St. George's hospitals. His fame as a lithotomist became widely known, and by his technic he was able to perform lithotomy by the perineal route in thirty seconds. In 213 cases, he lost only 10 per cent of his patients. At the age of fifty he retired from active surgery and took more interest in the Barber Surgeon Company. He saw the need for improved medical education and believed that it could only be effected by separation of the barbers and the surgeons, and when he was elected to the Court of the Barber–Surgeon Company he worked relentlessly to this end. In 1744 the surgeons finally made known their desire to be separated from the "gentlemen of the Barber side." The barbers protested that their numerous poor could not be provided for without the assistance of the surgeons, who insisted that their continued association with the barber side was not conducive to the advance of surgery. A special parliamentary committee was set up, and it was a strange coincidence that the Chairman of this Committee, a member of Parliament called Dr. Coates, was Cheselden's son-in-law. He it was who finally presented the bill in the House of Commons in 1745, recommending the separation of the surgeons from the barbers.

JOHN LISTER, M.D.

MASSACHUSETTS MEDICAL SOCIETY

POSTGRADUATE MEDICAL INSTITUTE COURSE IN GENERAL MEDICINE

A fifteen-hour course in general medicine is being offered by the Postgraduate Medical Institute. the fee for the full course being $25. A certificate will be issued for attendance at the course, which is recognized for credit by the Massachusetts Academy of General Practice. All sessions will be held in the Doctors' Library, Burbank Hospital, Fitchburg, Massachusetts, on Wednesdays from 2 to 5 p.m. The subjects are as follows:

JANUARY 7

DIABETES:

Surgical Complications of Diabetes. Dr. Richard Warren, chairman.
Certain Complications of Diabetes. Dr. Howard F. Root.
Management of Certain Complications of Diabetes. Dr. Charles C. Bailey.

JANUARY 28

PEDIATRICS:

General Surgery in the Infant. Dr. Orvar Swenson, chairman.
Radiologic Aspects of Surgical Problems in Children. Dr. Carroll Berman.
Neurosurgical Treatment of Congenital Anomalies. Dr. Donald D. Matson.

FEBRUARY 18

PULMONARY DISEASE:

Therapy of Bronchospastic Disease. Dr. Maurice S. Segal, chairman.
Newer Concepts in Pulmonary Functions. Dr. Edward A. Gaensler.

MARCH 11

URINARY ABNORMALITIES:

Management and Therapy of Renal Failure. Dr. W. Richard Ohler, chairman.
Certain Evaluations of Renal Failure. Dr. Arnold S. Relman.
Treatment of Edema. Dr. Kendall Emerson.

APRIL 1

GYNECOLOGIC PROBLEMS:

Common Gynecologic Problems. Dr. Langdon Parsons.
Gynecologic Office Problems. Dr. Christopher J. Duncan.
Prenatal Care and Immediate Management of Late Pregnancy Complications. Dr. Daniel J. McSweeney.

CORRESPONDENCE

CONCERNING ELECTRIC STIMULATION IN CARDIAC ARREST

To the Editor: I should like to make a comment on the editorial in the November 13 issue of the *Journal* entitled "Electric Stimulation in Cardiac Arrest." The writer comments on "an exceedingly promising report by Zoll," in the same issue of the *Journal*.

In another paragraph the writer states that open thoracotomy and manual massage of the heart constitutes a formidable procedure.

There can be no question that external electric stimulation applied through subcutaneous needle electrodes may cause ventricular contractions. The writer mentions further on in the editorial that such a procedure will surely be explored by many investigators in cardiac standstill during operation.

I should like to express the opinion that at present not enough thoracotomies and manual massage of the heart that stops beating suddenly during an operative procedure are being carried out. If a state of generalized hypoxia exists because the heart has stopped beating, it is still desirable to resort to a proved method of restoration of circulation to the brain and to the heart itself. Such an immediate restoration of stopped circulation can be *certainly* accomplished by sustained manual pumping of the heart, but I am not aware that any other method has been demonstrated to be equally effective in the emergency.

Electric stimulation applied through the intact chest wall may meet with little response from the cyanotic heart muscle

in which hypoxia has been allowed to continue. Immediate rhythmical squeezing of the heart by the hand can correct temporary hypoxia, after which electric stimulation may play its useful role either in the event that ventricular fibrillation supervenes or because the inert heart does not begin spontaneous contractions.

But in my opinion oxygen lack of the motionless cardiac musculature must be first corrected before response can be anticipated from this smooth muscle, whether it is stimulation by electric current or by a variety of drugs, which have been enthusiastically proposed to promote resumption of spontaneous cardiac rhythm.

So far as cardiac arrest in the operating room is concerned, since the available time limit for saving a life is so short, I hope that any premature enthusiasm for the employment of externally applied electric current in place of a knife and speedy direct massage of the heart by the surgeon's hand will not be eagerly adopted as a result of this editorial.

I should add that I liked Dr. Zoll's article. I thought that his enthusiasm was more restrained than that of the writer of the editorial.

PAUL R. HINCHEY, M.D.
355 Essex Street
Salem, Massachusetts

BOOKS RECEIVED

The receipt of the following books is acknowledged, and this listing must be regarded as a sufficient return for the courtesy of the sender. Books that appear to be of particular interest will be reviewed as space permits. Additional information in regard to all listed books will be gladly furnished on request.

Joll's Diseases of the Thyroid Gland. By Francis F. Rundle, M.D., F.R.C.S., The Unit of Clinical Investigation, The Royal North Shore Hospital of Sydney, Australia, and visiting surgeon, Prince Henry Hospital, Sydney. Second edition. 8°, cloth, 520 pp., with 165 illustrations and frontispiece. New York: Grune and Stratton, 1951. $12.75.

The first edition of this book was issued in 1932. This new edition, the work of Dr. Rundle, is based on the text of Dr. Joll. The material has been revised, and the publishing is good. The printing was done in Great Britain. The book should be in all collections on the subject.

A Manual for Psychiatric Case Study. By Karl A. Menninger, M.D. 8°, cloth, 355 pp., with 17 plates. New York: Grune and Stratton, 1952. $6.75. (Menninger Clinic Monograph Series, No. 8.)

This manual has been prepared for physicians entering the field of psychiatry. It contains all the essential material necessary for the collection, recording and analysis of data, records and case reports. A valuable appendix presents the nomenclatures of the American Psychiatric Association and of the Veterans Administration, a list of personality types, adjunctive therapy modalities, and a model commitment law. There is a good index, and the book is well published.

A Practical Handbook of Midwifery and Gynaecology for Students and Practitioners. By W. F. T. Haultain, O.B.E., M.C., B.A., M.B., B. Ch., F.R.C.P.Ed., F.R.C.S.Ed., F.R.C.O.G., honorary consulting obstetrician and gynecologist, Royal Infirmary, Edinburgh, gynecologist, Leith Hospital, consultant obstetrician and gynecologist, Bangour Hospital and Eastern General Hospital, Edinburgh, lecturer in midwifery and gynecology, Edinburgh University, and examiner in midwifery and gynecology, Triple Qualification and Fellowship Examination, Royal College of Surgeons, Edinburgh; and Clifford Kennedy, M.B., Ch.B., F.R.C.S.Ed., F.R.C.O.G., assistant obstetrician and gynecologist, Royal Infirmary, Edinburgh, honorary consulting gynecologist, Deaconess Hospital, Edinburgh, consultant gynecologist, Chalmers Hospital, Edinburgh, and Galashiels and Selkirk hospitals, lecturer in midwifery and gynecology, Edinburgh University, and examiner in midwifery and gynecology, Glasgow University, Triple Qualification and Central Midwives (Scot.) Boards and Fellowship Examination, Royal College of Surgeons, Edinburgh. Including a section on the "Management of the Infant and Neo-Natal Conditions," by J. L. Henderson, M.D., F.R.C.P.Ed., professor of child health, St. Andrews' University. Fourth edition. 8°, cloth, 412 pp., with 47 illustrations and frontispiece. Edinburgh: E. and S. Livingstone Ltd., 1952. $6.00.

The last edition of this standard handbook was published in 1947, and this fourth edition has been thoroughly revised and sections added on placenta praevia, delayed labor, venous thrombosis and dysmenorrhea. There are also chapters on the infant and on the uses of the x-ray in obstetrics and gynecology. There is a good index, and the publishing is excellent.

NOTICES

ANNOUNCEMENT

Dr. Frank A. Hamilton announces the removal of his office from 1402 Commonwealth Avenue, to 1381 Commonwealth Avenue, Allston 34, Massachusetts.

BOSTON GRADUATE CLUB OF PHI DELTA EPSILON MEDICAL FRATERNITY

A meeting of the Boston Graduate Club of Phi Delta Epsilon Medical Fraternity will be held at the Boston Club on January 21, at 6 p.m. After dinner, Mr. Samuel B. Horovitz, lecturer in legal medicine at Boston University School of Medicine, will speak on the subject "Doctors, Dollars and the Workmen's Compensation Act."

MASSACHUSETTS SOCIETY OF ANESTHESIOLOGISTS

The January meeting of the Massachusetts Society of Anesthesiologists will be held in the Joslin Amphitheater of the New England Deaconess Hospital, Boston, on Friday, January 9, at 7:30 p.m. Dr. Charles L. Burstein will speak on the subject "Circulatory Reflex Disturbances During Surgical Anesthesia."

LAHEY CLINIC LECTURES

Lectures will be held on the following dates in the Joslin Auditorium, New England Deaconess Hospital, at 7:30 p.m.:

January 7
Tumors of the Neck. Dr. Frank H. Lahey.
Tumors of the Mediastinum. Dr. David P. Boyd.

January 14
Coronary Thrombosis, Acute and Chronic. Dr. David I. Rutledge.
Cardiac Arrhythmias. Dr. Robert E. Foley.

January 21
Symposium on Radioactive Isotopes. Drs. Shields Warren, Elmer C. Bartels and John W. Norcross.

January 28
Symposium on Rheumatic Heart Disease. Drs. Robert E. Foley, Herbert D. Adams and Ferdinand A. Salzman.

SOCIETY MEETINGS AND CONFERENCES

DECEMBER 29–MARCH 23. Postgraduate Course in General Medicine. Page 697, issue of October 30.

JANUARY 3–31. Springfield Hospital Educational Program. Page 1000, issue of December 18.

JANUARY 3–JUNE 2. Mount Auburn Hospital Panel Discussions. Page 868, issue of November 27.

JANUARY 5. New England Cardiovascular Society. Page 1001, issue of December 18.

JANUARY 7–28. Lahey Clinic Lectures. Notice above.

JANUARY 7–APRIL 1. Massachusetts Medical Society, Postgraduate Medical Institute Course in General Medicine. Notice above.

JANUARY 7–APRIL 8. Postgraduate Medical Institute. Page 452, issue of September 18.

JANUARY 9. Massachusetts Society of Anesthesiologists. Notice above.

JANUARY 9–30. Combined Anesthesia Teaching Conferences of Boston. Page 785, issue of November 13.

JANUARY 13. Springfield Academy of Medicine. Page 1001, issue of December 18.

(*Notices concluded on page xi*)